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POWER

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The Consumptionist

I SEE that there is a new term in economics, the "Consumptionist."

An increasing number of people are waking up to the fact that if the owners and operators of the industries are going to make much money out of their products, there must be a large number of people with money enough to buy them.

If the economies of mass production are to be continuously realized, the masses have got to be well enough off to absorb the output.

Statistics show that with the help of the greatly increased amount of power now available per worker with automatic and labor-saving machinery, it takes only sixty-odd per cent of the human labor that it used to take to do the work that used to be done.

What, then, becomes of the other thirty-odd per cent?

Some of it is taken care of by cutting down the hours of labor. The twelve-hour day that men still working once knew, has given place to eight hours; holidays are frequent and the week is shortened a half-day in many and a whole day in some industries.

Improved methods have made life easier for all.

Another important influence has been what the labor leaders call the "conscientious withholding of efficiency," restricting the amount that a workman will do in a given time.

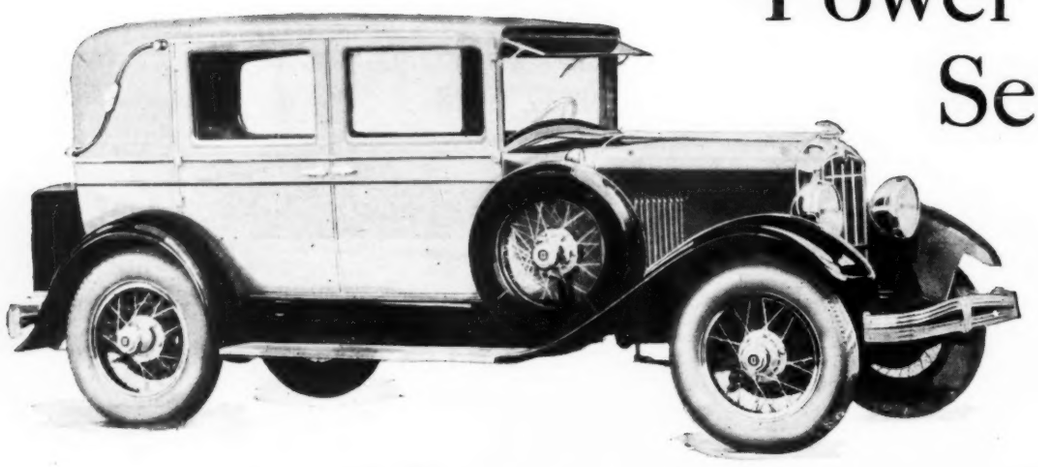
In this way everything is made more expensive for everybody; and it bears the hardest on the classes that practice it. The more intelligent of the labor leaders have found this out and are encouraging real craftsmanship and application.

Another way in which the labor thus set free has been absorbed, has been by the creation of new industries. The automobile, the radio, numerous electrical appliances and developments in the chemical industries have given employment to thousands making things we got along without.

But there is no use of making them if hosts of people have not the means to buy them.

And hence the entry of the consumptionist and the realization that in order that industry may thrive and wax great, labor must be given a generous share of its products. The industries collectively have got to finance their markets.

F. R. Low



Power Services in an Automobile Manufacturing Plant

By Graham L. Montgomery
Editorial Staff. Power

THE plant of the Durant Motor Company of New Jersey, at Elizabeth, N. J., is one of the largest automobile plants under one roof in the world. The more than 2,000,000 sq.ft. of floor space is used for the Eastern operations of this company in manufacturing the Durant and Star cars and for the manufacture of automobile bodies by the Hayes-Hunt Corporation.

Automobiles are not made in their entirety at this plant. All the castings and many of the other parts are made elsewhere. Some parts are made in the plant and all the finishing and assembling work is done there.

The Hayes-Hunt Corporation makes a specialty of body building, and manufactures, in that part of this plant which it rents, bodies in addition to those needed for supplying the local Durant output. This company also makes for the Durant company all the sheet-metal and pressed-metal parts needed except frames, since this work fits in nicely with the sheet-metal work necessary in body building.

The works engineers department of the Durant company supplies all the power services and maintenance required by the two companies. Since there is no definite

Fig. 1—Air view of Durant plant at Elizabeth, N. J.

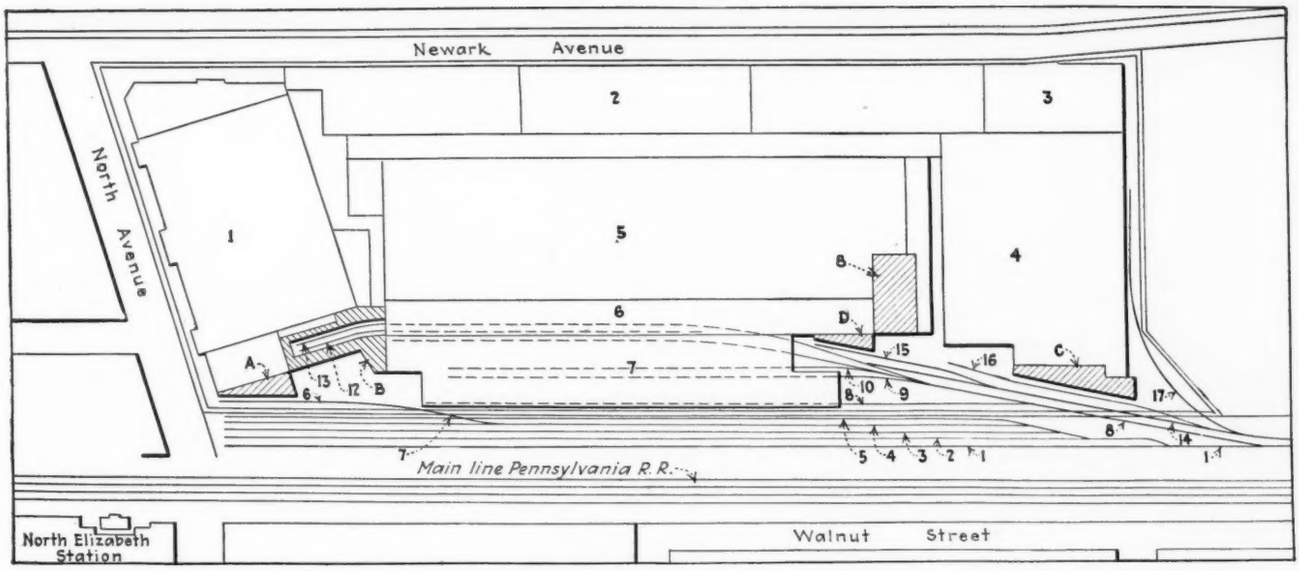


Fig. 2—Layout of Durant plant, showing location of various manufacturing areas

relation between the production of these two units, the Durant company having turned out 40,027 complete cars at this plant in 1926, while the Hayes-Hunt company built 78,709 bodies, the supplying of the power services will be treated as though there were but one company.

Referring to Fig. 2, which shows the layout of the buildings in the plant, of which Fig. 1 shows an airplane view, the course of the car through the plant can be traced. Materials are brought into the plant at the unloading areas *A* and *B* on tracks 6, 12 and 13. They

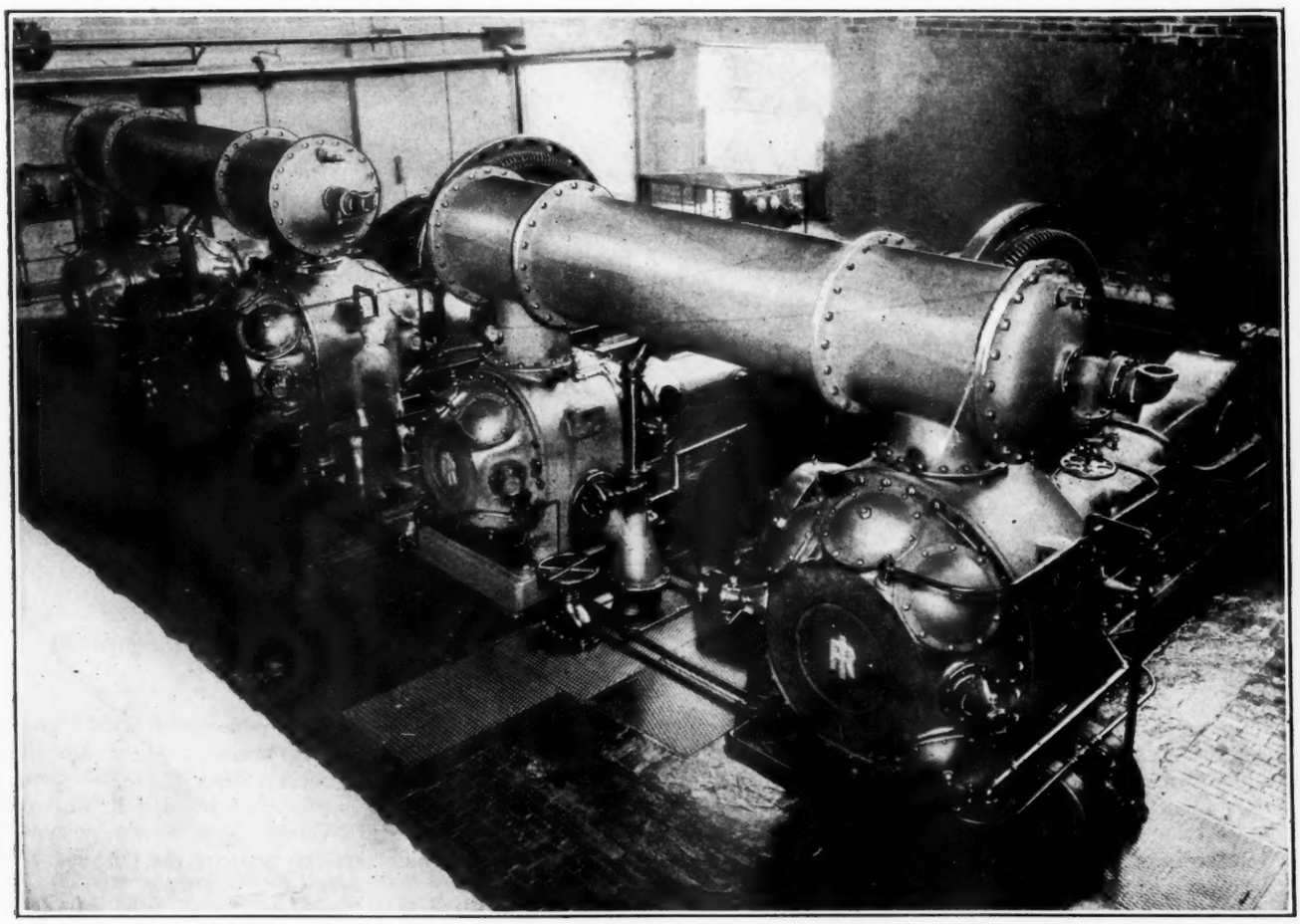


Fig. 3—Installation of air compressors at Durant plant

then move through areas 1 and 5, while being prepared for assembling. Assembly is carried out in the three divisions of area 2. Bodies are built in area 4 and the adjacent part of area 5. Those to be assembled on cars at this plant are delivered to the assembly line in area 3. Painting of parts and bodies is done in the space between

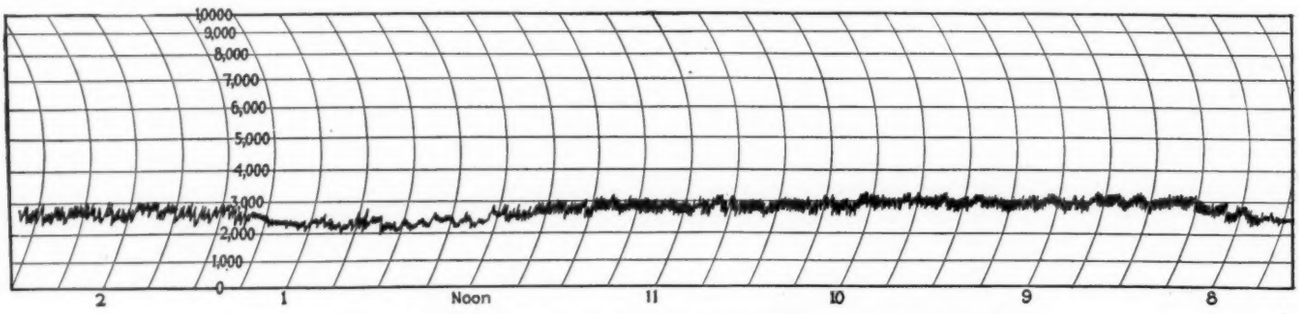


Fig. 4—Chart showing total electrical load for seven hours of a typical day

areas 2 and 5, in the upper part of which are the drying ovens. Completed cars and bodies are loaded out in the areas 6 and 7. The power plant and coal storage are located at 8 and *D*. Maintenance stores and shops are in the basement of area 5.

Manufacturing of the type done at this plant requires rather more compressed air and less electric power than is the case with most metal-working shops, because a large number of the parts requiring machining are made

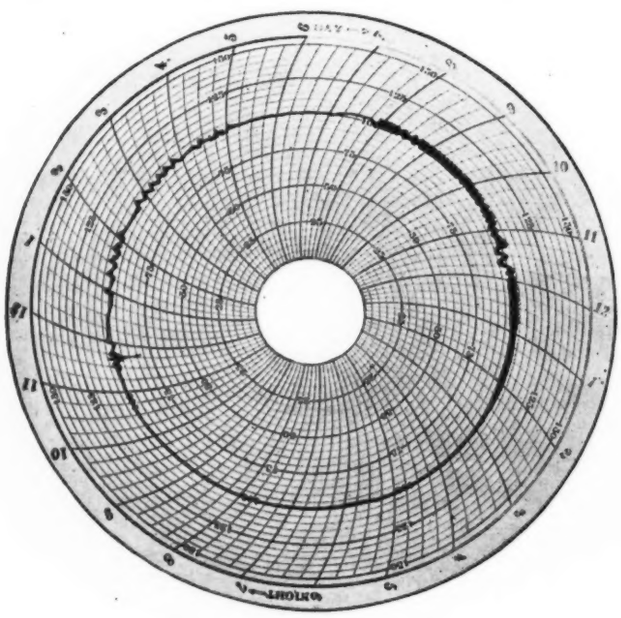


Fig. 5—Air-pressure chart, showing uniformity of operation

in other plants and shipped in. Machine operations of the pressing and punching type are, however, used extensively and require electric power. Most of the conveying is done by compressed air, and operations in the finishing and assembly work are largely carried out with air tools.

In carrying out this manufacturing work, steam is used for power generation, driving auxiliaries, heating buildings, conveying ashes, process heating, paint drying and cafeteria operation. Alternating current is used for illumination, direct-current generation, motor operation, compressor drive, and electric process heat. Direct current is generated for the electric-driven conveyors, which need variable-speed motors, and for other variable-speed motors used. Compressed air is used as the motive power for most production tools, for hoists, and for all conveyors in the body plant, which are of the air-cylinder pusher type.

The power plant consists of three main divisions—boiler room, turbine room and air compressor room. The boiler room contains six Connelly cross-drum, water-tube boilers each with 6,020 sq.ft. of heating surface. These boilers generate steam at 190 lb. with 125 deg. superheat. They are equipped with Coxe stokers.

The generating equipment consists of two 2,000-kw.

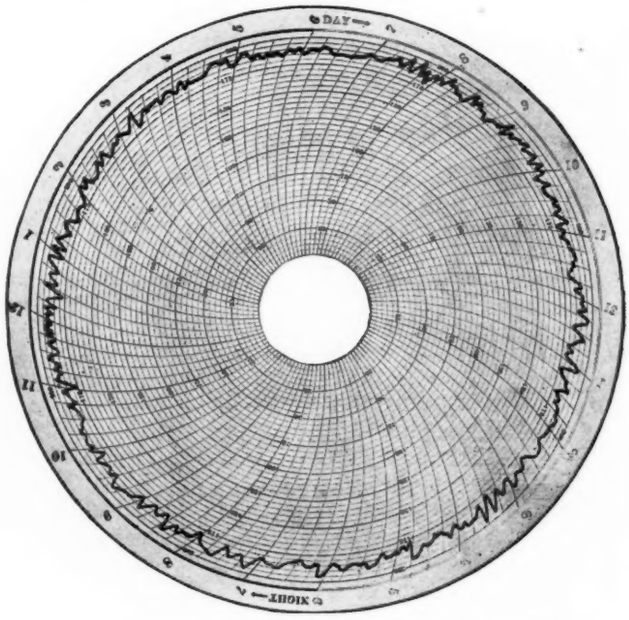


Fig. 6—Steam-pressure chart, with hand regulation of boilers

four-stage extraction turbine-generators and one 3,000-kw. four-stage turbine-generator. These are of General Electric make and generate three-phase, 60-cycle current at 480 volts. Air is compressed to 105 lb. in two Ingersoll-Rand, 5,000-cu.ft. compressors driven by synchronous motors, which serve to improve the power factor of the plant.

This power plant was fully described in *Power*, Vol. 58, No. 17, Oct. 23, 1923, pages 638-43. Since that time

the only major change has been the air compressors, the motor-driven units, shown in Fig. 3, having recently been installed in place of the steam-driven units described in the article mentioned, which had a combined capacity of only 4,900 cu.ft. of air as compared to the 10,000 of the new installation. The new compressors are type PRE, heavy-duty, duplex, direct-connected compressors. Their characteristics are shown in Table I. The total output of the boiler plant in 1926 was 619,506,470 lb. of water evaporated. Of this amount approximately 570 million pounds was used directly in, or to generate, the services discussed herein. For driving generating equipment, auxiliaries and steam-jet ash conveying, 54.5 per cent, or 336,620,000 lb. of steam was used in 1926. The consumption of steam by the turbines was 225,571,000 lb.; by the auxiliaries, 93,226,000 lb.; and, for the ash conveyor, 17,822,000 lb.

Building heating steam is supplied from a low-pressure header that receives all the exhaust steam from the steam-driven auxiliaries and such additional steam as may be necessary by extraction from the turbines. This header, in addition to supplying the heating steam, is connected to the feed-water heater, so that, when steam is not being used for building heating, it can be utilized there. This building heating service required 126,384,933 lb. of low-pressure steam during 1926.

Process work required a supply of 108,884,000 lb. of steam in 1926. For drying ovens used in connection with body manufacture, about 43,000,000 lb. of this steam was used. The remainder was used for various miscellaneous industrial and process purposes about the plant.

The production of electricity for 1926 was 10,487,020 kw.-hr. This current is used for power, light and heat. The distribution among the various service classifications, together with the corresponding steam requirement and the percentage of the total which this makes, is given in Table II. The total amount of air compressed during 1926 was 869,966,000 cu.ft. From Table II it is seen that this required 74,056,543 lb. of steam, or 8.5 lb. of steam per 1,000 cu.ft. of free air compressed. This compressed air is all used for power service, none for process work. Since records are not kept dividing the air power uses, as is done with the electric current, it is not possible to subdivide this air as to its applications.

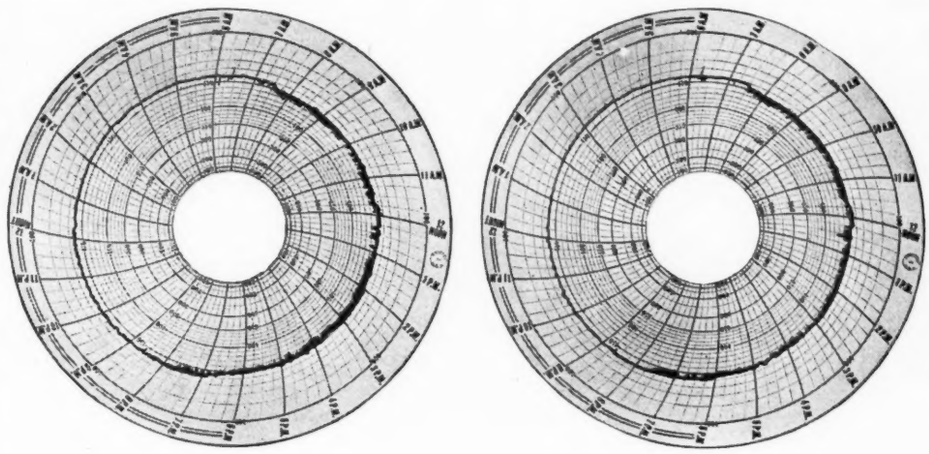


Fig. 7—Voltage charts from two different days, showing similarity of power service requirements

The demand for each of the power services is, within certain limits, constant for each car and body turned out. These limits are the methods of manufacture used, which change over a period of years, but in any one year are practically constant.

The plant management determines, for a given period, the rate of car and body production for the plant. Knowing this, the works engineer, who is the executive in charge of all power-generation and application, can easily predetermine the rate at which to supply the power services. The building heating load is the only important service not based directly on the rate of production. Its supply must be based on past experience, modified by actual weather conditions as they occur.

An example of the steadiness of the load is shown by Fig. 4. This is a chart from the totalizing meter, taken

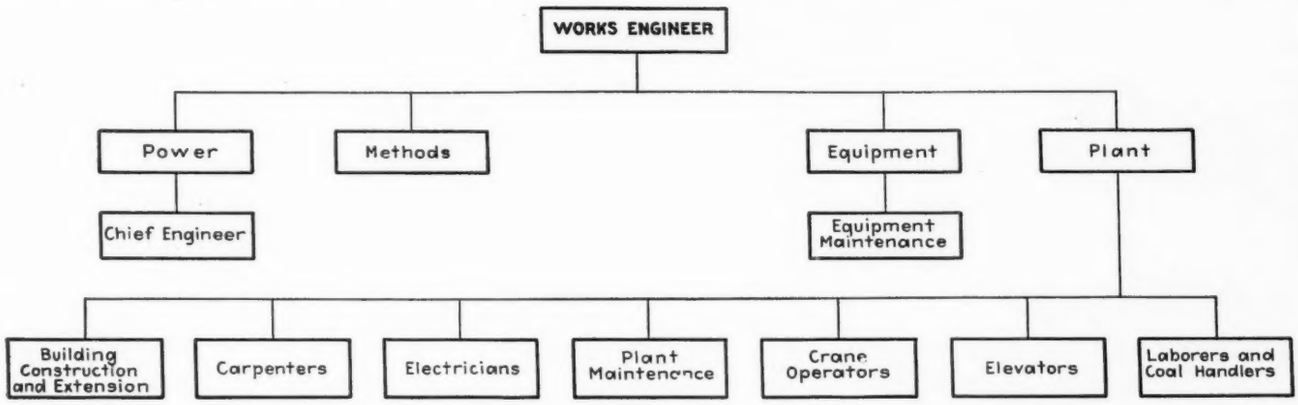


Fig. 8—Organization chart of works engineer's department, showing management control of power services

at random for a day in which the plant was in full operation. It is evident from this chart that a maximum variation of 7 per cent in the use of electricity is found over a typical day's run.

The same steadiness characterizes the use of compressed air. Fig. 5 shows a sample air-pressure chart.

TABLE I—CHARACTERISTICS OF AIR COMPRESSORS IN DURANT MOTOR COMPANY PLANT

	Capacity, Cu.Ft.	Brake Hp. at 100 Per Cent Power Factor	Motor Efficiency, Per Cent
Full load	4,335	817	93.3
¾ load	3,251	632	93.1
½ load	2,167	447	92.0

TABLE II—DISTRIBUTION OF ELECTRICAL LOAD WITH CORRESPONDING STEAM REQUIREMENTS AND PERCENTAGES OF TOTAL REQUIREMENTS

Service	Electrical Requirement in Kw.-Hr. per Year	Steam Requirement in Lb. per Year	Per Cent of Total Steam Used for Power Generation
Light for body plant	1,568,069	50,493,097	15.00
Light for sheet metal plant	421,770	13,464,826	4.00
Power for body plant	497,530	15,989,480	4.75
Power for sheet metal plant	485,453	15,484,550	4.60
Power for air compression	2,302,894	74,056,543	22.00
Power for d. c. generation	171,720	5,554,241	1.65
Power for cranes	62,340	2,019,724	0.60
Power for pumps and compressors	649,916	20,870,480	6.20
Electricity for heating	2,697,399	86,511,507	25.70
Light and power for car mnf.	1,629,929	52,176,200	15.50
Totals	10,487,020	336,620,648	100.00

It will be noticed that, even though the hours of the day when the use of air is at a minimum, from 8 a.m. to 2 p.m., the variations in pressure caused by fluctuations in use are but slight.

Fig. 6 shows a typical steam-pressure chart made during a period when steam pressure was being controlled by hand. This chart also shows a very steady use of steam, the variations in the curve being confined to a movement between 180 and 190 lb., caused by the slow response of hand control.

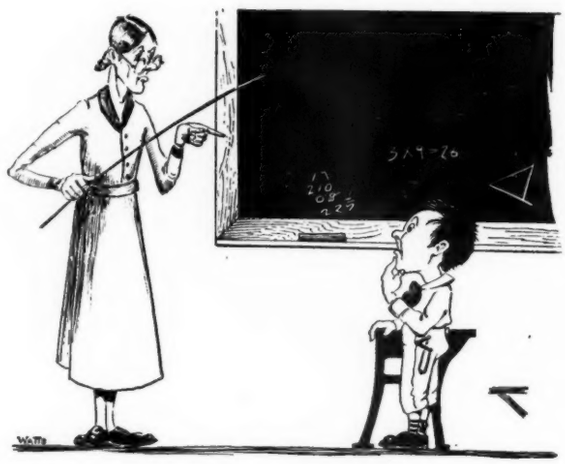
Fig. 7 shows voltage charts from two days in September, 1927. These charts illustrate how well the power service can be scheduled when the rate of car and body production is known. Although they were separated by about two weeks, they are almost identical in variation, showing the similarity of one day's operation to another.

How the Services Are Controlled

The power plant services are tied up in their control with all other plant service departments, as is most often the case in the modern industrial plant. Control of all these departments centers in the office of the works engineer, whose responsibility covers power (services), planning (not for production, but for all operating departments), equipment (purchase, installation and maintenance) and plant. This latter department includes sub-departments for electrical, pipe-fitting, construction, machine shop, blacksmithing, carpenter and miscellaneous work, and for material handling, maintenance stores and elevator operation. All these departments have working foremen reporting to the works engineer. The power plant and power services are controlled by a chief engineer, also reporting to the works engineer.

In this way the control of the generation, transmission and application of power services for the plant, together with all the maintenance work, is centered under one head. This makes it possible to co-ordinate all the plant services, whether power services or maintenance services, in such a way that production is free from avoidable interruptions and can be carried out at the desired rate with high economy.

For the information upon which this article is based and the illustrations, the writer is indebted to C. L. Allen, works engineer, Durant Motor Company of New Jersey, and to that company, whose kindness is hereby acknowledged.



What Do You Know?

By L. H. Morrison

The answers are on page 553

Ques. 1—Why do radial-cylinder and rotary-cylinder gasoline engines have odd numbers of cylinders?

Ques. 2—Is it possible for a Corliss engine having all four valves operated from a single wristplate to cut off later than one-half stroke?

Ques. 3—In drilling an oil well, will the drill make a hole with its axis along the earth's radius?

Ques. 4—With a given engine will the crank bearing pound less if fed oil by gravity or if supplied by a pressure feed?

Ques. 5—Would a bevel of 45 deg. on the calking edge of a boiler plate be satisfactory?

Ques. 6—What is meant by degree-day in heating?

Ques. 7—Will a gas increase or decrease in temperature in passing adiabatically through an orifice from a high to a low pressure, the discharge and inlet velocities being the same?

Ques. 8—What should be the furnace volume per ton of pulverized coal fired per hour, if water-cooled walls are used with a boiler?

Ques. 9—Is all of the energy used in compressing the injection air on a Diesel, returned in the energy of the spray jet?

Ques. 10—What air leakage is good practice to allow in the condenser of a turbine-generator unit?

Addenda to the A.S.M.E. Boiler Construction Code permits tube holes to be counterbored where the metal is thicker than that required to get a proper bearing by expanding, so as to form narrow seats into which the tube ends can be properly expanded, provided there is space available to permit of a proper amount off flare of the tube end.

Restoring Services in a Large Industrial Plant After a Flood

By G. W. ATKINSON

WHEN the Connecticut River dike broke at Springfield, Mass., last November and flooded many residences and factory sites, there were several problems presented for immediate solution, which had never been considered by this generation. The entire factory floors on the ground level of one large industrial concern were flooded with water one foot deep.

Approximately 2,000 ft. of underground tunnels were completely filled with water; most of these tunnels were from six to seven feet high and ranged from four to ten feet in width. They contained all the main lines for electric lights, power, signals, water, steam, gas and air services from the power plant to the various buildings. But little damage was done to any lines except the electric system, but these were put out of commission as soon as the water reached them. In fact, the energy from the power plant was cut off all mains before the water made them inoperative. An auxiliary city service for light and power was in place, but as the main feeders from the transformer station to the power plant ran in a section of the main tunnel, the service had to be abandoned at the same time that the power plant was put out of use.

FLOODS that put power systems out of commission do not occur often, but when they do, quick thinking and good judgment on the part of the plant engineer are called for, if full advantage is to be taken of every available resource to get the plants back into service in the minimum time. This article, which tells how service was restored in a large plant where about fifty motors and many miles of distribution lines were flooded and the power plant shut down, contains many useful suggestions.

This was during the first week in November, and as all buildings were piped with a wet sprinkler system, there was danger of the system becoming frozen. It was imperative that steam be put on the mains as soon as possible in order to furnish heat. The first task was to clear the tunnels of water. All the walls and floors were of concrete. No sewer connections were in place, therefore all the water had to be pumped. In the power plant there was some centrifugal pumping equipment, which was used on the water circulating system for the condensers, that had not been flooded. These were driven by 40-hp. motors. A temporary overhead power service line was run from the city transformers, and one motor was soon made ready for running. Some extra lengths of 8-in. iron pipe were run from the pump suction connection to the tunnels, about 30 ft. distant. The pump was primed by city water, and in a short time it was delivering water at the rate of 1,200 gal. per min. to the spray pond, where a temporary board trough was made to carry the water to the street sewers. Eight hours later, when the surface water had subsided, the tunnels were sufficiently emptied to permit steam to be turned into the heating mains.

The power plant had been flooded and fires under the boilers had been out for about twenty hours. The furnaces were oil fired, and there was not sufficient steam pressure to run a fuel-oil circulating pump or to furnish steam for atomization in the oil burners. The steam-driven yard locomotive was run within a hundred feet of the boiler room, and an emergency steam pipe line was run from it to the power plant, where connections were made to supply the oil pump and atomization lines with steam. Within an hour there appeared the most welcome sound ever heard around a plant—that familiar sound when steam first passes into a cold piping and radiator system in a large office building.

The plant was equipped with an underground fuel-oil storage system having a nominal capacity of 300,000 gal. As all the tanks had been thoroughly anchored in place when they were installed, there was no trouble or evidence of any of them coming out of the ground, even though the surface water covered the whole area, and within 24 hours the normal ground-water level had risen to the surface. Several neighboring tanks, which had not been properly anchored, were lifted by the buoyancy of the water. One tank measuring 7 ft. diameter by 35 ft. long not only came out of the ground and broke its piping connections, but was carried several blocks down the street by the torrent of water.

The next most difficult of all problems and the least

dependable for success was that of restoring all the electric feeder systems in the tunnels to an operating condition.

A megger test on any or all cables showed dead short circuits or grounds. The oldest part of the system had been in place fifteen years, and many extensions had been made during that time. All cables had been run in either fiber or iron conduits, which were run open in most places, but were sometimes buried in the concrete ceiling construction, especially all the fiber ducts. Practically all cables were rubber insulated and braided. No sectional cutout switches had been installed for the various lengths of 1,000 to 1,200 feet.

Our first move was to open and remove the covers on all junction and pull boxes, fittings or other accessible outlets. We then attached rubber hose to the 90-lb. air lines and started blowing out the entrained water in the conduit system. This operation was repeated several times. It was soon discovered that the greatest defect in insulation was at the joints where connections had been made. Varnished cambric had generally been used, with a covering of friction tape, and the work was not impervious to water. It was found advisable to remove a great deal of the tape at these joints.

After the cables were thoroughly dried, the joints were re-covered with high-grade rubber insulating tape and the usual layers of friction tape for final protection. This was considered the best type of insulating material for use where the cables were subjected to moist air and on which the operating voltage did not exceed 600. Where joints were left with the old tape intact, the cables were temporarily separated from each other and held in position by small strips of rubber packing or dry-wood blocks. This left sufficient space for air to circulate between conductors and evaporate the water.

Electric Heaters Were Used

At several of the large junction boxes we devised an expedient method of drying by placing electric heaters near the locations and directing the hot currents of air by means of desk fans. At one end of a tunnel the air temperature was quite high due to the presence of a large number of high- and low-pressure steam pipes. The circulation of the ambient air was not satisfactory. A propeller-type motor-driven fan was removed from a unit heater in the factory and placed in operation at this location. An immediate improvement was noticed in the drying condition. Other sections of the tunnels were opened at all available vent places in order to let the air circulate and carry out the moisture.

Periodic readings and records were made with meggers so that a definite check could be made on the progress of the drying. In a few days the entire feeder system with several miles of wire was in operation again and very few feeders had to be replaced except one or two that were very old and had been overloaded to such an extent that the insulation would crumble when disturbed. The electrical points to be gained from such an experience may be expressed in a few words which forcefully emphasize the following of good engineering practice by installing all such cables with lead coverings and wiped joints and no fuses or switches in the tunnels for branch circuits. In the factory there were approximately fifty alternating-current squirrel-cage motors that became partly or wholly soaked with the flood water. They were located on or near the floor and ranged in size from three-quarters to twenty horsepower. All these motors showed defective insulation. They were removed, disassembled, cleaned, and the stators were placed in drying ovens. Megger readings and records were made to indicate the progress of the work. Some of the motors dried out in fifteen hours and others took twice that time before they had sufficiently high insulation resistance, usually 50,000 ohms as a minimum.

Practically all these motors had been used on metal-working operations. Some of them were several years old and their insulation was cracked. This permitted the fine metal dust to be washed into contact with the conductors, and they could not be repaired by drying and coating the coils with insulating varnish. About 40 per cent of these motors had to be rewound or at least have certain defective coils replaced. In the drying out process it was soon discovered that a comparatively new motor having good insulating material took the longest time to dry. An old motor with numerous small breaks or cracks in the insulating material would provide ample vent spaces for the escaping moisture, and it was soon restored to a satisfactory condition provided its pores were not filled with metallic particles.

Close the Circuit Breaker Before the Switch

By Duffie Johnson

MANY air-break type circuit breakers are not provided with trip-free attachments, therefore they can be held closed when tripped by an overload. All such circuit breakers should be closed before closing the switch. If there is a short circuit or overload on the line, the circuit breaker can open when the switch is closed. If the switch is closed first and then the circuit breaker, in case a short circuit exists on the line, the breaker cannot trip open. Under such conditions there is danger of injuring equipment that the breaker is intended to protect, interrupting the circuits to other equipment and also badly burning the contacts of the circuit breaker.

While employed as inspector of motors in a steel plant, I made an investigation to determine the cause of an interruption of all motor operations in the wire mill. An electrician's helper was called to a motor that was not operating satisfactorily. After stopping the machine and clearing up the trouble, in attempting to start it again, he made the mistake of closing the switch before closing the circuit breaker.

The arm of the starting box, although released by the coil during the previous shutdown, remained in the running position in this instance. It was held by a burr on the last contact point. Therefore, when the circuit was closed with the breaker, the line potential of 110 volts was impressed across the low-resistance armature circuit, which allowed a sudden rush of current through the motor circuit. The breaker tried to open the circuit, but the electrician forced it to remain closed by pulling on the handle in an effort to get it into a fixed position. In the meantime the circuit breaker of the wire-mill mains at the substation opened, and the operations of twenty-six motors supplied through it were interrupted.

If the electrician had closed the circuit breaker of the motor before closing the switch, the former could have opened the instant the switch was closed and no other part of the system should have been noticeably affected.

High-Frequency Current

A Master Magician

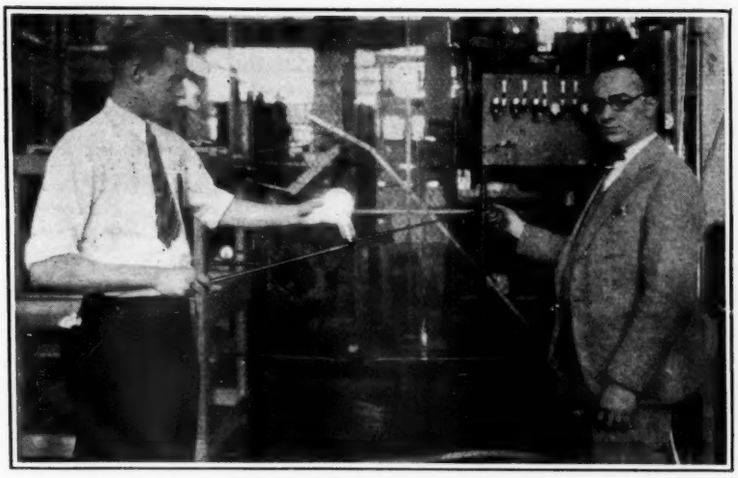


Fig. 1—A 250-watt lamp lighted by energy picked up on the road

AN INCANDESCENT lamp, pulled from its carton for the first time, lights to full brilliancy without wires or socket; a copper bar lying on the floor, blisters the hand that picks it up, though the metal is cold; a neon tube suddenly floods the room with its lurid red glow when merely touched by a spectator; meters in adjacent rooms run wild, and parts of delicate measuring instruments are twisted or broken, so that all accurate scientific work in the vicinity is impossible; these and many other strange freaks are produced by a new high-frequency vacuum tube about six inches in diameter and two feet long, recently developed by engineers of the General Electric Company laboratories at Schenectady, New York. This tube, which is shown in Fig. 4, has a capacity of 15 kw. at 50,000,000 cycles and a 6-meter wave length. It can be seen at *A* in Fig. 2 and the antenna at *B*. A piece of carbon in the end of this antenna will burn with a flame two feet high as in Fig. 3. E. D. McArthur and his assistant are seen holding a receiving antenna while the assistant lights a 250-watt lamp by touching its base to the antenna. The receiving antenna is about eight feet away from the sending antenna, which can be seen about one inch below the former.

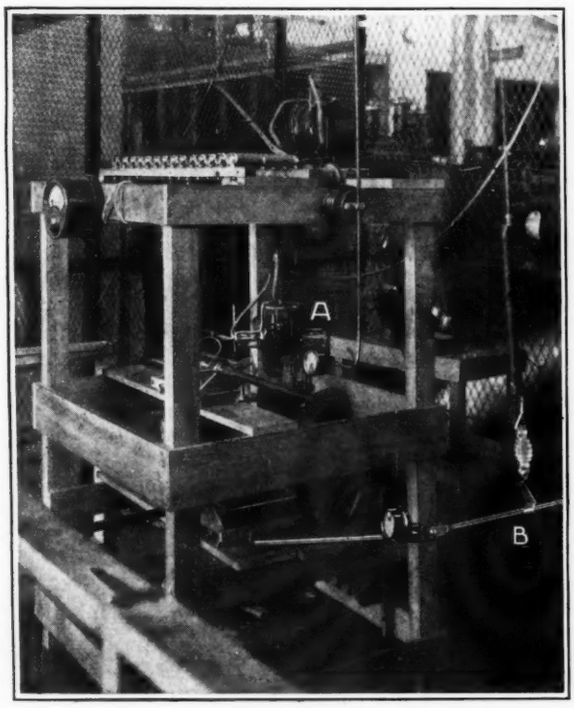


Fig. 2—Equipment used in the high-frequency experiments

Fig. 3—Flaming antenna

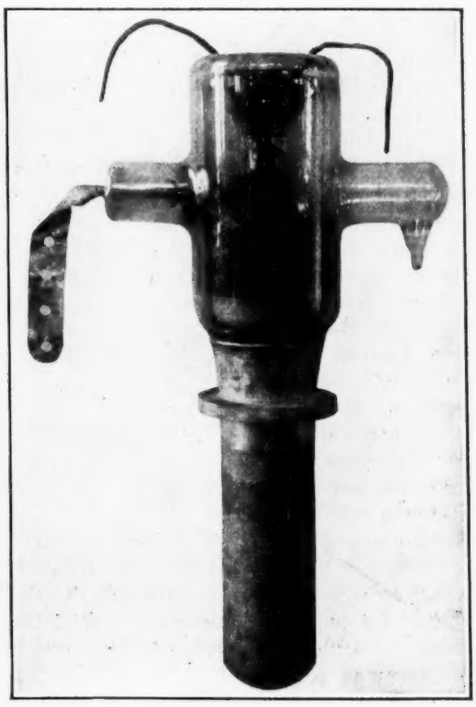
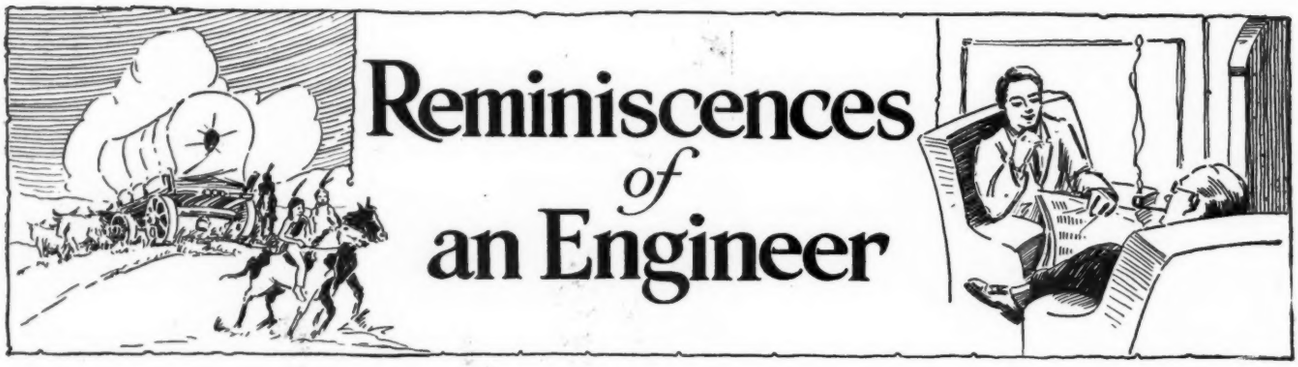


Fig. 4—Fifteen-kilowatt high-frequency tube



Engineer Ed on the Frontier

By Hubert E. Collins

THE old Chisholm Cattle Trail had seen two of its twenty years of romance, when a strange cavalcade started against the tide of cattle herds from Texas moving toward the southern railhead at Abilene, Kansas, where they would be loaded on cars for Chicago.

Leading the van was a wagon frame with the platform of the bed filled to overflowing with a sawmill engine and accessories. The next following was another wagon to which was lashed a locomotive-type boiler. Behind these came three wagons with a circular-saw outfit, including the ratchet carriage. Then, and not the least, came wagons bearing food supplies for all the men, enough to last several days.

Operation of power plants of today call for much technical knowledge but the glamour of the old days of the Corliss engine and fire-tube boilers is missing. This is the first of several stories, in which the author will relate experiences of various engineering friends, of his youth. In these tales the scene ranges from Metropolitan New York down through the Indian country and along the old Chisholm Trail. One essays a venture into the Colorado gold fields, builds mining hoists and invents safety devices—in fact the movies have had no series of episodes equalling those of Collins' friends in their hegira through life.

The drivers were seasoned frontiersmen, all in charge of a slender young fellow wearing the blue cap of the Union Army. Riding "on point" were two frontiersmen, both then famous, Buckskin Joe and California Joe. The undertaking there started was to transport a sawmill outfit to Darlington Agency on the north bank of the North Canadian River, deep in the Cheyenne and Arapahoe Indian country, and there erect it. It was a momentous time on that wild frontier; the departing wagons were accompanied to the edge of town by the notables of Abilene to wish them well and bid *adios*. Mounted on a large black horse in the front of this farewell party was a fine-looking man, with black wavy hair coming to his shoulders, black broad-brimmed Stetson and dark "store clothes." He was gotten up regardless, was the Town Marshal, Wild Bill Hickok, and was there to do honor to the leader, Edwin F. Williams, an engineer.

With many yells and curses the freight train was urged to speed; men and jacks were all on parade. Even the twelve-horse team with the boiler in tow broke into a trot, which was paced by all the others, raising an immense dust from the bare surface of the trail.

Every scout carried rifle, six-shooter and knife, each mule skinner had his Winchester in its scabbard close at hand, and the young army man held a rifle across his knees as he rode on the seat of the lead wagon. As they had started at early sunrise, they camped for dinner ten miles out, and brought up for the first night well on toward the Arkansas River crossing.

Williams had started in a blacksmith shop, served in a machine shop, had been appointed government engineer of Darlington Agency and thus started to the scene of his first appointment, taking charge of his machinery from the unloading at the end of the railroad to the erection at the newly established Agency. On the trail the party was looked upon as important by the Westerners, for it meant the first permanent sign of civilization in the country overrun by the fighting Cheyennes and their allies.

Across country they wended their way down the famous cattle trail of song and story, down river banks, through water, up the opposite banks. After reaching Bluff Creek, they passed through teeming herds of buffalo, for the spring feeding migration was on.

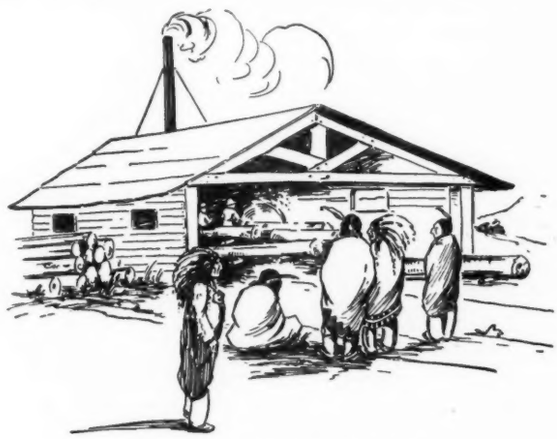
Accompanying these were herds of elk and antelope. They flushed quail and prairie chicken every mile of the way. It was a veritable hunter's paradise; seldom were they out of sight of game at any time. Night voices about the camps included the hoarse bark of wolves, the querulous cry of the coyote, and the screech of the owl.

Often parties of wild Indians rode up to inspect the invaders of their domain. One evening there was quite a confab with the Indians, during which they learned that Ed was a blood relation of Tosimeeah, their friend and agent. From that time forward the trip was made with the aid of these red warriors, they often helping through the quicksand of fords, pointing out the places they knew were safe to cross.

The Buzz Saw Disturbs the Red Man

Eventually, they reached a settlement of tents covering the Agency employees until the new sawmill turned out that which would make permanent homes.

The machinery thus transported was unloaded on the north bank of the North Canadian River in the presence of thousands of Indians. Villages were situated in groups which betokened in each the gathering of warriors and their families under a leading chief. Up and down the two-mile wide bottom land of the river called *Honeo* (Wolf) by the natives, these villages extended as far as the eye reached, while a similar sight met the gaze on the opposite bank of the river. All day long parties of restless Indians from distant points with feathers flying, buffalo-hide shields clattering on encased bows, rode up on their wiry ponies and crowded about the strange equipment. As they sat about on steeds that never stood still, the bucks' heels drummed an incessant tatoo on the animal's ribs. These Indians were of the fiercest fighters on the plains, just confined on their first reservation. They were far from subdued, went on the war path in earnest four years after the

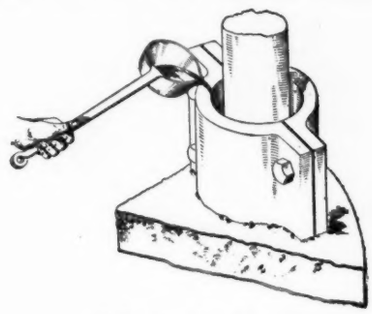


The passing of the tepee

date of this story and furnished hundreds of warriors to help annihilate General Custer at another time.

A small company of government employees were gathered into the few tents surrounded by the Indians. The nearest military post was Fort Dodge, Kansas, some 200 miles to the north and west of the Agency site. The only protection for these few whites at this time was the presence of the Quaker, Brinton Darlington. This man had met all the warlike tribes and secured their promise to accompany him to the site and sit down in peace. They named this man their Tosimeeah, gave him full allegiance and protected him and all his blood relations.

As there was peace on all the frontiers of the West that year, many army men and officers had been discharged from service. One officer, who had fought in



A bad cake has uses

many Indian campaigns, was Col. Eugene Carr, afterward raised to the rank of general. Carr came into the camp the day after Ed's arrival; he rode down from Fort Dodge to ask for a job, for with the prodigality of the frontier he was "down to hardpan"; the gamblers had his pay. He was put to work as a helper, as was Tom, Donnel the scout who had accompanied Carr.

The boiler, engine and saw outfit were set up in the open, on skids hewn out of the blackjack of adjacent river bottoms, and the first lumber was sawed while the machinery was still without shelter. The gang got out the first timber and drew it to the skidway. Soon there was timber to house the outfit. Then the material was prepared to house the Agency employees. All window frames and door jambs were made on the ground, and these houses served as homes until the State of Oklahoma was opened to settlement, nineteen years later. Engineer Ed went to live in one of the houses with his brother and sister-in-law. Then followed some years of operating the sawmill he had set up, as the demand for lumber increased. His work helped establish the first settlement in that country.

The White Man's Winning Ways

The operation of the sawmill was not without its excitement. There came times when it was hard to keep helpers. When the Agency doctor came, he had his son with him. The Holloways lived in one of the newly built houses in the Agency, and Frank, the son, went to work for Engineer Ed. Frank was an unrestrained, healthy young man with no patience, neither could he gage the character and thoughts of the Indians about him. As the working of the sawmill was a strange curiosity to them, no day's work was without an audience of silent, watchful red warriors in paint and feathers. They would get out of the way if they understood when so requested. As the Indians spoke no English, one had to go about such request with signs and a large portion of patience. Holloway, lacking this latter quality, one day got into trouble. Finding a warrior in his way on the skidway who did not move when spoken to, Frank tripped and pushed the offender down on his back. The man was not hurt, except in his pride, and arose from

the ground with eyes blazing murder. As he stepped from his house in the Agency that evening, the offended warrior met him and shot him to death. The whites were compelled to assemble with Agent Darlington for protection until the excitement died down, and engineer Ed was minus a helper.

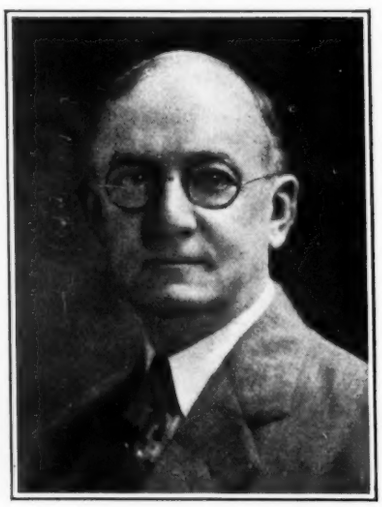
He soon had another helper in the person of a young cowboy who rode into the camp one day. He seemed anxious to remain out of sight and watched every stranger who rode up. He seemed a zealous worker and educated beyond the usual cow puncher. About a week after the arrival of the latest helper four men rode up and peered into the sawmill building. They noted the helper; he saw them Without bidding good-bye, the helper soon went to the corral, saddled his pony, mounted and rode away, never to return until brought in by Indians, wounded almost to death with a large-caliber bullet through the head. He had been found forty miles away. He regained consciousness and was nursed back to life. He said before he left again that he had gone to sleep in his blanket at the end of the day he had left and remembered no more until he had come-to at the Agency. Thirty years afterward, Edwin F. Williams met the head of a manufacturing business in Connecticut who told him of having spent some of his youth in the West. He had gotten into bad company and joined a gang of horse thieves. Finally, he awoke to the fact that he must leave them if he expected to get out of the country alive, so went to an Agency and found work in a sawmill. His gang following him, he tried to get away, slept out the first night on the trail and awoke back in the Agency badly wounded. He knew the gang had followed him and had left him for dead. Williams revealed himself as the Agency employer but agreed never to reveal the secret.

There were times when operations need be suspended in the sawmill while the few whites lay low and watched from behind barricades, as blood-thirsty warriors demanded revenge from the only whites within reach, for wrongs inflicted on the red nation by others.

At another time a soldier-helper took a pot shot, with the engine frame as a rest, at an Indian on the river bank almost a mile distant, just to see how close he could come to the mark. He succeeded in taking off the Indian's heel. Again there was rest from work with all on guard, as Indians investigated the possibility of the shot having come from the mill. Ed was successful in making the warriors believe the man had been shot from another direction.

Upon the discovery of the rich silver lodes at Leadville, Colorado, Ed gave up the government job at Darlington agency and joined in a rush to the mines.

Soon after his arrival he set up hoisting engines in the new mines, for the firm of Hendrie & Bolthoff, whose shops were then at Council Bluffs, Iowa, later removed to Denver. A greater part of the mining machinery set up during the first year of Leadville's hectic life, was placed by this young engineer of the frontiers.



Hubert E. Collins

The young man took the luck of a wild mining camp in living experience, together with the others. The young machinists who worked with Ed gathered together under the mothering of a boarding house "missus." Especially did they detest the cake, which was far from being "like mother used to make." The missus thought her confection to be perfection, so the boys dared not refuse it even though each piece typified a case of indigestion for some one.

One day when she filled their dinner pails, she topped them off with her cake and they went to work with the intent of throwing the stuff away. During the morning they found they must rebabbitt a number of bearings. They had no fireclay. Why not try the cake. Each was overly anxious to contribute his quota to the common weal. The job of rebabbitting went merrily forward, with landlady's cake used as successful backing against the hot molten metal. Triumphantly, they returned to their quarters and reported to the kitchen Goddess, "Your cake is the best ever." They did not say how it was best.

The Invention of the Safety Catch

When the mines developed into deep shafts, men were lowered to work in buckets, let down by the cables running over the drums of the hoisting engines. One day the bucket filled with men was drawn against a stop and the cable broke. Several lost their lives, and others escaped with crippling injuries. Then and there, Ed devised the first safety clutch, the forerunner of the present safety on elevator cars. As is often the case, this safety device put thousands of dollars of royalties in pockets of others than the inventor. He had the usual inventor's luck.

Several of his vertical direct-connected units also went into mines in Colorado and New Mexico owing to early contacts on the frontiers.

He made a study of the force of inertia, and, as told by Charles T. Porter, made the first instrument with which to measure this force.

When the steam turbine became the important prime mover, he turned his attention to turbines and worked on a design which, however, was never brought out. He also worked on an oil-engine design for the West Point Foundry & Machine Company. This was so long ago that few had faith in the success of such a radical idea, and the work was dropped, to be taken up in the last decade and pushed to success. His design of a uniflow engine was his last work, performed for a well-known manufacturer of the present day. In fact, this engine is the only product of the manufacturer and has the greatest sale of any uniflow engine.

The life of Edwin F. Williams is inspiration to any operating engineer who aspires to a future. Romance has even followed him to his last resting place. From his grave one can look out on the site of Commodore Perry's battle and victory on Lake Erie. So modest was he that his name is little heard, although he was an early developer of the large steam engine.

Graphs That Save Calculation of Boiler Stack Draft

By C. H. Baker
Consulting Engineer, Montclair, N. J.

TEDIOUS work is frequently entailed in arriving at boiler stack drafts by the well-known empirical formulas for this quantity. Graphs are here presented to enable the engineer to determine draft with greater ease.

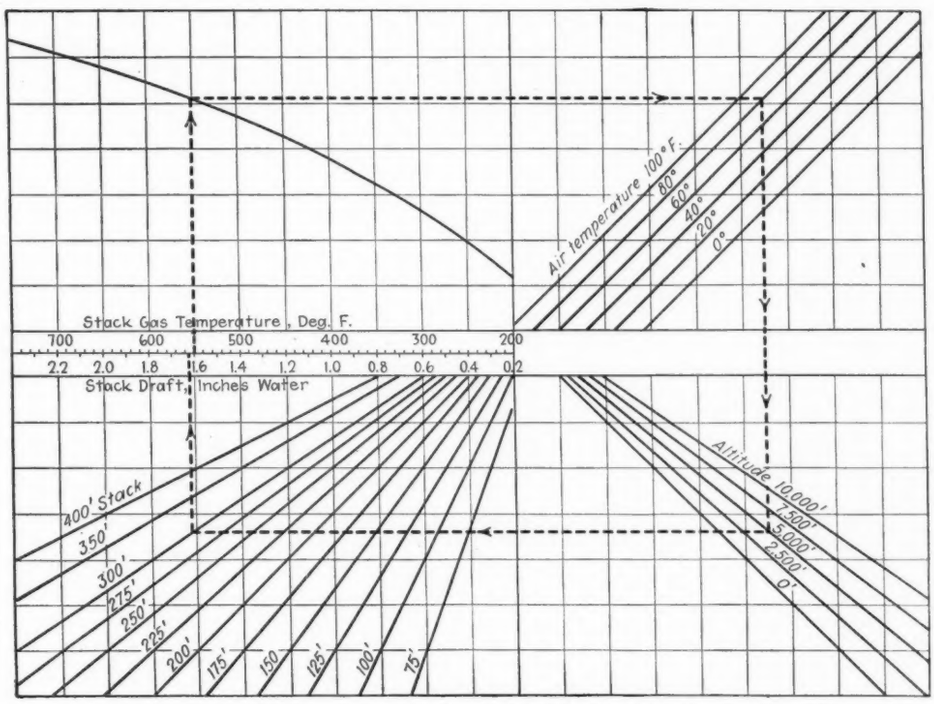


Fig. 1—Chart for determination of theoretical boiler stack draft

The quantities for obtaining draft are so given as to save computing their equivalents. For instance, velocities are omitted and gas weights are expressed in per cent

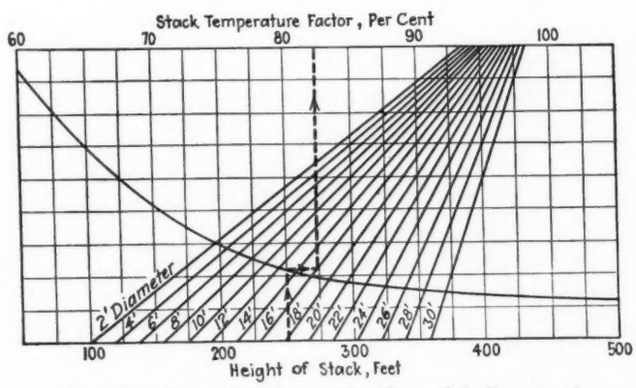


Fig. 2—Chart for determination of boiler stack gas temperature factor

CO_2. A conversion graph is included to facilitate the use of other quantities, if so desired.

Boiler stack draft is produced by the difference in weight between the column of heated gases within the stack and the weight of an equal column of external air. This weight difference obviously varies with the height of the stack and the densities of gases and air, which in turn are governed by the temperatures.

This maximum draft intensity is usually expressed as follows:

$$D = 52\,P_1 H\left(\frac{1}{T} - \frac{1}{T_1}\right)$$

where D = Theoretical draft, in. of water; P_1 = Atmospheric pressure, lb. per sq.in.; H = Stack height, ft.; T = Absolute air temperature, deg. F.; T_1 = Absolute stack gas temperature, deg. F.

Atmospheric pressure is ordinarily expressed in inches of mercury, and letting P = barometric pressure in inches of mercury, this formula becomes:

$$D = 0.255\,PH\left(\frac{1}{T} - \frac{1}{T_1}\right)$$

Fig. 1 developed from this formula, illustrates a rapid method of obtaining stack-draft intensity for ordinary problems. The dot-and-dash line, when followed in the direction of the arrows, indicates a draft intensity of 1.62 in. for a 300-ft. stack at 5,000 ft. elevation above sea-level with stack-gas temperature of 500 deg. F. and an external air temperature of 80 deg. F.

Since draft intensity is largely a function of the temperature of the stack gases, the cooling of these gases by radiation after entering the stack should not be overlooked. The average

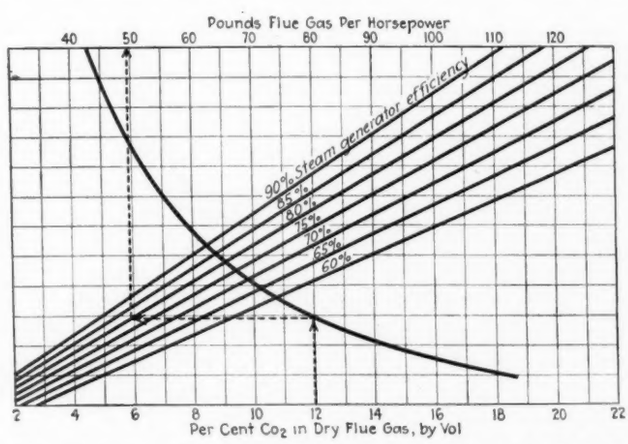


Fig. 3—Chart for determination of weight of boiler flue gas per square foot of heating surface, when 10 sq.ft. of heating surface is equivalent to 1 boiler horsepower

temperature of the gases in the stack is frequently taken at 80 per cent of the entering gas temperature. Fig. 2,

plotted from data by the late Mr. Cotton, indicates a closer approximation of this ratio for brick stacks. The illustrated problem on this chart shown by the dot and dash line, indicates that the average stack gas temperature is 82.3 per cent of the entering flue-gas temperature.

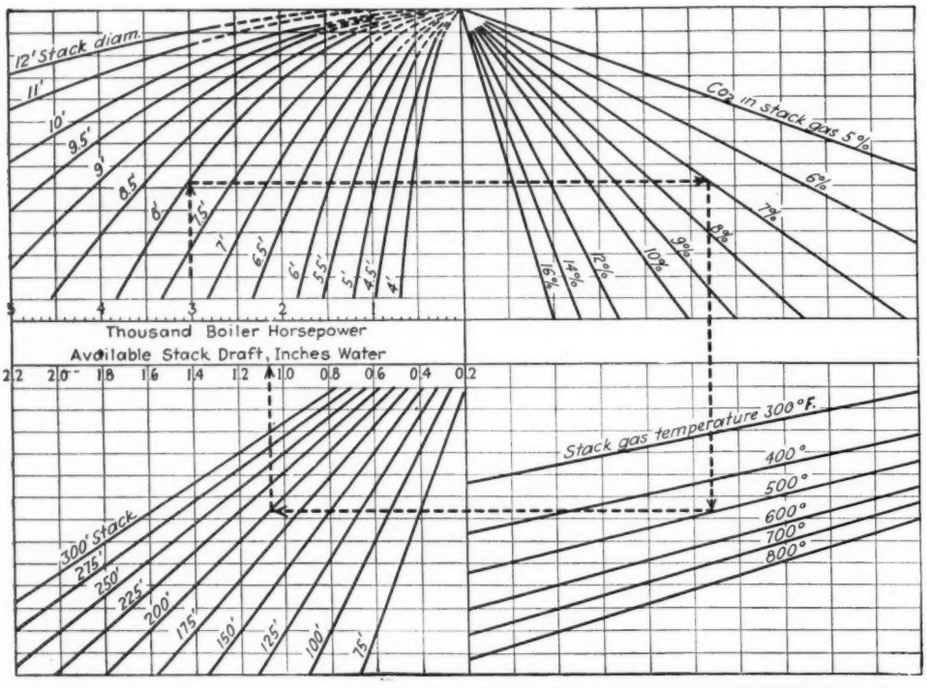


Fig. 4—Chart for determination of available boiler stack draft for plants of from 0 to 50,000 sq.ft. of heating surface

The stack draft loss due to friction is generally based on Chézy's formula, which may be expressed as follows:

$$D_f = \frac{KV^2H}{D_s T_1}$$

where D_f = Friction loss, in. water; K = Constant = 0.0097, which is 20 per cent above the average derived from authentic tests; V = Velocity of stack gases, ft. per second; H = Height of stack above breeching, ft.; D_s = Stack diameter, ft.; T_1 = Mean absolute temperature stack gases; hence

$$D_f = \frac{0.0097\ V^2H}{D_s - T_1}$$

For convenience this formula has been changed to gas weights and by assuming a gas density of 0.085 at 32 deg. F. and 30 in. barometer reduces to

$$D_f = \frac{2.29\ W^2HT_f}{d^5_s}$$

where W = lb. stack gases per second and d_3 = stack diameter, in.

Available stack draft is the maximum obtainable or theoretical draft less the total resistance to the flow of the gases in the stack. The resistance to inertia is usually so small that it may be neglected, so that the available stack draft may be considered as the difference between theoretical draft and friction losses.

Since the weight of the products of combustion for a given CO_2 per unit of heat liberated by various coals has been established within close limits, the same relationship will hold per unit of heat absorbed when the efficiency of the heat-absorbing elements is known.

Fig. 3 shows this relationship expressed in pounds of gas per each 10 sq.ft. of heating surface. The problem indicated on this chart shows that with the flue gases having 12 per cent CO_2 and the boiler operating at 80 per cent efficiency, the weight of the flue gases per square foot of boiler heating surface will be 5.98 pounds.

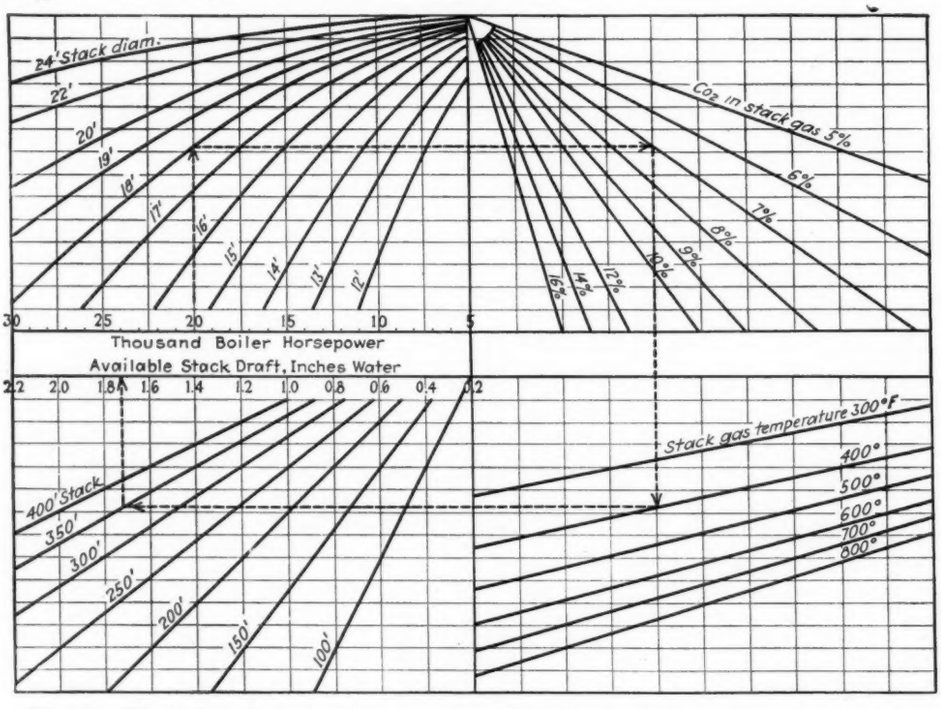


Fig. 5—Chart for determination of available boiler stack draft for plants of from 50,000 to 300,000 sq.ft. of heating surface

Figs. 4 and 5 show a convenient method of obtaining the available stack draft for any stack from 4 to 24 ft. in

diameter and from 75 to 400 ft. in height for boilers operating 80 per cent efficient at sea level and 60 deg. F. air temperature.

The problem indicated on Fig. 4 illustrates an available draft of 1.08 in. obtainable for 30,000 sq.ft. of heating surface at 80 per cent efficiency on an 8-ft. diameter stack with 7 per cent CO_2 or 83.7 lb. of gas per hp. in stack gases with average stack gases temperature of 500 deg. F. and for a 200-ft. stack.

Likewise Fig. 5 indicates that for 200,000 sq.ft. of heating surface and 80 per cent efficiency with an 18-ft. diameter stack, 7 per cent CO_2 and 400 deg. F. temperature of stack gases and a 350-ft. stack there is an available draft of 1.72 in. of water.

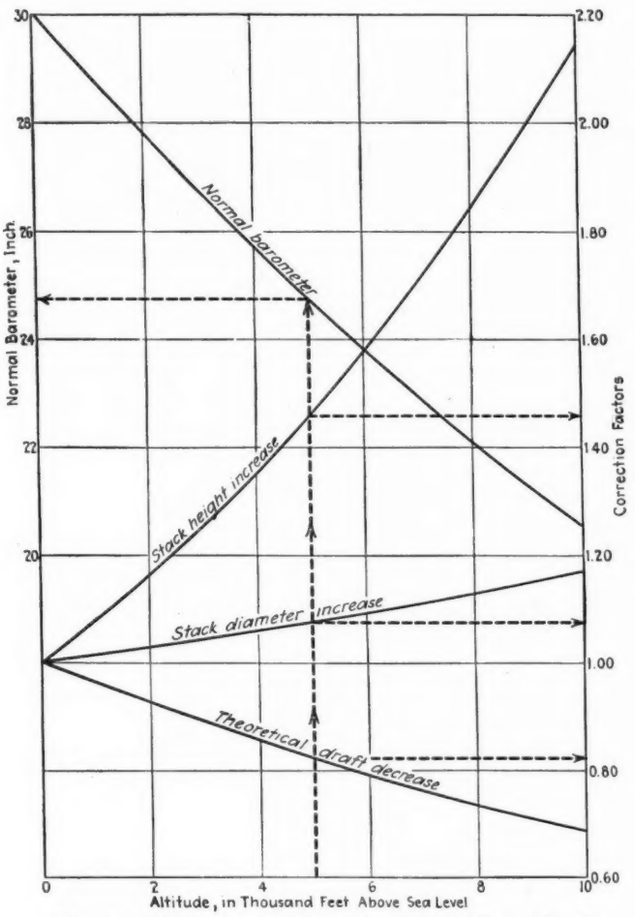


Fig. 6—Boiler stack correction factors for altitude and normal barometer

Corrections for atmospheric temperatures other than 60 deg. F. may be derived from Fig. 1.

Since the density of air and gases decreases with increased altitude and the air required for combustion is constant for a given forcing rate, the gas velocities will be increased and obviously increase stack friction loss. The velocity for a given forcing rate will vary inversely as the barometric pressure, and the velocity head will be inversely proportional to the square of the barometric pressure.

Hence the height of the stack will vary inversely as the square of barometric pressures. Added friction loss occasioned by the increased height and velocity may be compensated for by increasing the stack diameter on the order of the two-fifths power of the barometric pressures. Fig. 6 shows the correction factors together with normal barometer pressures assumed for altitudes from sea level to 10,000 ft.

Answers to What Do You Know

The questions are on page 544

Ans. 1—For a constant interval between impulses, the explosion must occur in alternate cylinders and the number of cylinders must be odd.

Ans. 2—The usual Corliss design is such that with one wristplate and one eccentric operating the four valves, cutoff must occur before mid-stroke of the piston, but the Nordberg Corliss has a valve gear which includes a second eccentric so connected with the governor and valves that cutoff can take place after mid-stroke.

Ans. 3—No; the well will not be along a radial line, but will be deflected. In some deep wells the bore is in the shape of a corkscrew, and in one case the bottom was 500 ft. off the radial.

Ans. 4—Experiments demonstrate that the blow absorbed by the babbitt is five times as great when the oiling is by gravity as compared to that with pressure feed.

Ans. 5—The A.S.M.E. Boiler Code, in P. 257, calls for a beveled edge not sharper than 70 deg., consequently the 45-deg. edge would not be allowed.

Ans. 6—The degree-day represents the product of one degree of temperature and a time factor of one day. It is commonly used to indicate the variation of temperature from 65 deg. F., which is taken as the minimum mean daily temperature below which bodily discomfort will result. Thus if the mean temperature for a given period, say, two days, has been 45 deg. F., the heating requirements may be expressed as 40 deg.-days, and if the period was one day it would be expressed as 20 deg.-days.

Ans. 7—It has been found that gases behave differently. Most gases, such as carbon dioxide, for example, cool, while hydrogen and helium at ordinary conditions heat, although at low temperatures they behave as do the other gases.

Ans. 8—Fair values range from 600 to 1,200 cu.ft. per ton.

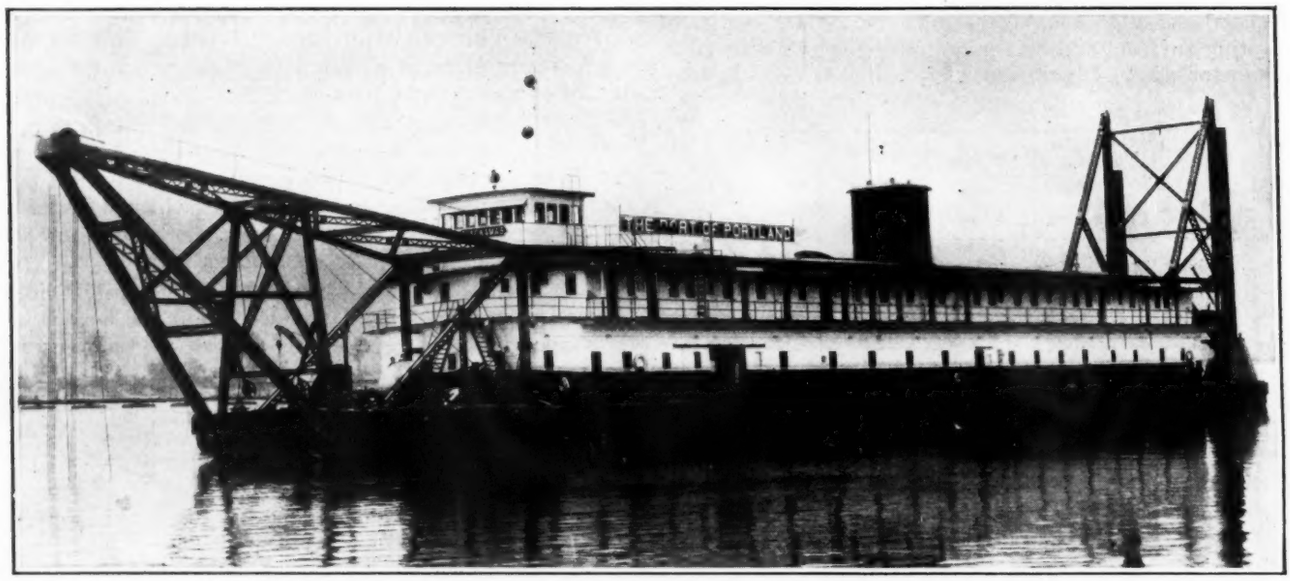
Ans. 9—A part of the work of compression is removed by the compressor intercoolers. This, along with the work used to overcome frictional resistance, is not returned in the spray.

Ans. 10—The leakage should not exceed 7 cu.ft. per min. when the turbine is in good condition.

Coming!

Vibration of turbines and their foundations gives many an engineer sleepless nights. In the next two issues, POWER *will present a thorough discussion of this perplexing subject by an expert, T. C. Rathbone, of the Westinghouse Electric & Manufacturing Company.*

INTERNAL COMBUSTION ENGINES



Diesel-electric dredge "Clackamas" equipped with a 3,400-hp. power plant

DIESEL AND STEAM COSTS *on "Oregon"*

BY JAMES H. POLHEMUS
General Manager and Chief Engineer of The Port of Portland, Oregon

WHILE the data obtained in their full detail are applicable only to hydraulic dredges, nevertheless valuable information can be extracted from the compilation by analyzing the items that apply to the power plant and its auxiliaries. In other words, the accounts are so segregated that, with little adjustment, both operating and maintenance costs for the power plant itself can be determined.

However, to understand better the figures, a brief description of the dredge and a summary of the work done may be useful. Particular interest attaches to this dredge because it was the first large Diesel-electric plant of its kind to be placed in operation and now has had a sufficiently long operating period, (25 months, running day and night) to make the data really indicative of what may be expected from this type of equipment.

Following two years of continuous operation and after completion of a thorough overhauling of wearing parts, The Port of Portland has been able to determine some interesting data upon the operating and maintenance costs of a Diesel electric power plant on a dredge.

The figures are for the 30-in. hydraulic pipe-line dredge "Clackamas," which was built in 1925 by The Port of Portland Commission for the work of improving the channel of the Willamette River and the harbor at Portland, Ore.

In securing the present deep and wide fairway to the sea, the main reliance has been upon dredging, and this accounts for The Port of Portland's owning and operating a fleet of four 30-in. hydraulic dredges. Two of these are 1,200-hp. steam dredges and one a steam dredge of 2,000 hp. using geared turbines to

INTERNAL COMBUSTION *Engines*

drive the dredge pump. These and the Diesel-electric dredge, the "Clackamas," make up the fleet. The latter is powered with two 800-hp. and two 900-hp. Diesel engines, a total of 3,400 hp. There is an auxiliary 110-hp. Diesel engine. All Diesels are directly connected to direct-current generators which feed to a common bus.

The main pump motor pulls 2,700 hp. or more when the dredge is working on long pipe lines. Frequently, heavy sand is delivered through 10,000 ft. of 30-in. pipe lines at an elevation of 25 to 35 ft. above the water level, which is an unusual performance for hydraulic dredges.

TABLE I—OPERATING AND MAINTENANCE COSTS PER HORSEPOWER-YEAR

2,000-hp. steam dredge, oil fuel:	
Operation	$88.99
Maintenance	24.14
	$113.13
2,700-hp. Diesel electric dredge:	
Operation	$50.92
Maintenance	24.64
	$75.56

During a period of 25 months, in which the dredge ran a total of 623 operating days, 12,286,025 cu.yd. of sand, gravel and clay were removed from the harbor at Portland and deposited in fills on shore. This output reflects an average of 19,720 cu.yd. per operating day and is practically twice the average output of the 2,000-hp. steam-turbine dredge.

A comparative analysis recently made shows that the operating and maintenance costs for the "Clackamas" were $75.56 per horsepower per year, while for the 2,000-hp. steam dredge, using oil fuel, the costs were figured to $113.13 per year. On a yardage basis the "Clackamas" shows a cost of $0.0345 per yard, while the steam dredge output on oil fuel cost $0.0746 per cubic yard. It is interesting to note that the maintenance costs per horsepower-year were practically the same for both dredges, the saving being in operating costs. Referring to shaft horsepower at the dredge pump, the figures found for each dredge are given in Table I.

Cost accounts kept by The Port of Portland are segregated into such detail that it is possible to select those items that apply only to the power plant. In the case of the dredge "Clackamas" the plant includes the four large Diesel engines previously mentioned, one 110-hp. Diesel; the generators, switchboard and controls; air and oil tanks and piping, compressors, pumps, etc., or just about the equipment of a power plant that might be used for any power service and having the facility of being made up in units so that various load demands, up to the maximum capacity, might be met economically by operating only as many units as necessary over any period.

In the dredge accounts the items that apply are shown in Table II. A cost of $306.19 per operating day is the total for operation and maintenance. The actual power output for the 623 operating days over which this average is obtained, was 22,379,700 kw.-hr., or an average of 35,922 kw.-hr. per day. The maximum for one day was 49,400 kw.-hr. At the foregoing average figures a cost of $0.0085 per kw.-hr. is reflected. It should be borne in mind, of course, that these figures are not put forth as reflecting what it would cost to generate electric current by the use of Diesel engines. Many other elements of cost would have to be taken into consideration, such as interest and depreciation, housing of plant, etc. Also there would be certain savings, particularly in the labor cost. Our figures include the entire engine-room crew, which is large because of their duties extending to dredging machinery. However, these costs are undoubtedly of value when considered with due regard for these other factors, as they are the carefully accumulated, actual costs for a Diesel-electric plant that has been in continuous day and night operation for six days each week over a period of twenty-five months and has been thoroughly checked and repaired after such operating period.

The fact that two months were used in overhauling the dredge as a whole does not mean anything so far as the power plant is concerned. The dredging machinery, suction and discharge pipe cutting equipment, etc., require repairs and replacements about every two years and engine-room work can be done leisurely during the time the dredge is thus idle.

Reference to Table II will show the distribution of repair costs to the units of the power plant. The writer feels that the totals are rather higher than they should be, but can quote only the totals as accumulated in the cost accounts. The totals of approximately $15,000 charged to each pair of Diesel engines represents mostly the cost of spare parts ordered during the first year. Much of this charge is applicable to, and should be distributed over, a period of several years, some probably over the life of the plant. Even so, the plant needed to have these spare parts on hand and therefore such purchases are a part of operating cost. If more than one plant is owned, spare parts should be carried in inventory accounts and charged for as used, but we have had no incentive to do this with the "Clackamas." In any event, we feel that leaving these first-year spare-part costs in the summary makes the total cost figures safer, and the showing for economy of this plant is still very good.

TABLE II—COST OF POWER PLANT OPERATION AND MAINTENANCE FOR DREDGE "CLACKAMAS" FROM AUGUST, 1925, TO NOV. 30, 1927 (623 OPERATING DAYS)

Operation	Totals	Per Operating Day	
Labor in engine room	$58,935.80		$94.60
Oil fuel	64,839.45		104.09
Engine department supplies:			
Lubricants	10,938.08	$17.56	
Packing	737.85	1.18	
Miscellaneous supplies	4,262.16	6.84	
Lighting supplies	1,344.60	2.16	
Electric machinery supplies	131.82	0.21	
Oil cooling supplies	8,063.92	12.94	40.89
Total operation	$149,253.68		$239.58
Maintenance			
Two 900-hp. Diesel engines	$15,440.61	$24.78	
Two 800-hp. Diesel engines	14,922.81	23.95	
One 110-hp. Diesel Engine	484.52	0.78	
Four main generators	1,824.53	2.93	
One auxiliary generator	102.42	0.16	
Air tanks and piping	152.35	0.24	
Switchboard requirements	408.33	0.66	
Cooling tanks and piping	288.94	0.46	
Lubrication tanks and piping	3,216.56	5.16	
350-lb. air compressor	47.57	0.08	
1,000-lb. air compressor	.....	0.00	
Fuel oil cleaner	1,571.77	2.52	
Lubricating oil cleaner	2,908.10	4.67	
Fuel tanks and piping	132.99	0.22	
Total maintenance	$41,501.50		$66.61
Grand total	$190,755.18		$306.19

INTERNAL COMBUSTION *Engines*

Buda Company Builds a Light-Weight Diesel

THE light-weight Diesel suitable for tractors, trucks and other mobile equipment has experienced its greatest development in Germany. The Buda Company, of Harvey, Ill., obtained a license to build the M.A.N. light-weight Diesel in the United States and after certain modifications is now offering this engine in both four- and six-cylinder units ranging from 50 to 90 hp. A cross-section of the engine, which has a bore of 115 m. (4.5 in.) and a stroke of 180 mm. (7.12 in.), is shown in Fig. 2.

One of these Diesel truck engines has been in service for several months in a truck owned by the Buda Company and has been put in service parallel with their gasoline trucks. This engine (Fig. 1) is rated at 50 hp. and weighs 1,100 lb. It was installed in a four-ton truck chassis without any alteration being required in the hood length or radiator. The four-ton gasoline truck is ordinarily fitted with a 4½-in. bore by 6-in. stroke four-cycle gasoline engine.

Learning to operate this Diesel truck required no more effort or time than to learn to operate a gasoline truck.

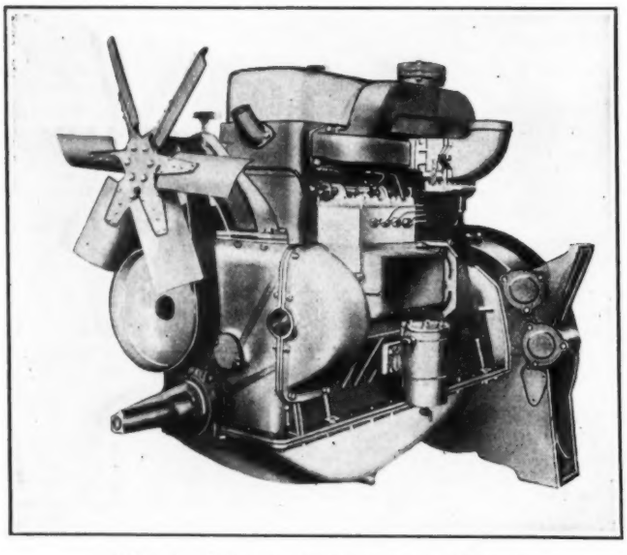


Fig. 1—The Buda high-speed Diesel

In addition to the greater economy the driver soon discovered that the Diesel engine had far better torque.

The air inlet pipe has a pre-heater attached, to aid in starting under extremely cold conditions and is arranged for the application of an air filter. The exhaust pipe is large and has an outlet flange suitable for attaching a muffler.

All parts are completely inclosed, but are readily accessible by removing the handhole plates, push-rod covers, or cylinder-head covers, the latter two being held by one hand nut each.

The cooling is accomplished by the conventional centrifugal water pump driven off the gear train. Provision is made for the generator drive off the extended water-pump shaft.

Force-feed lubrication to all moving parts is a feature. This is effected by a dual-geared pump operating a dry sump system. Oil is taken from the supply tank mounted

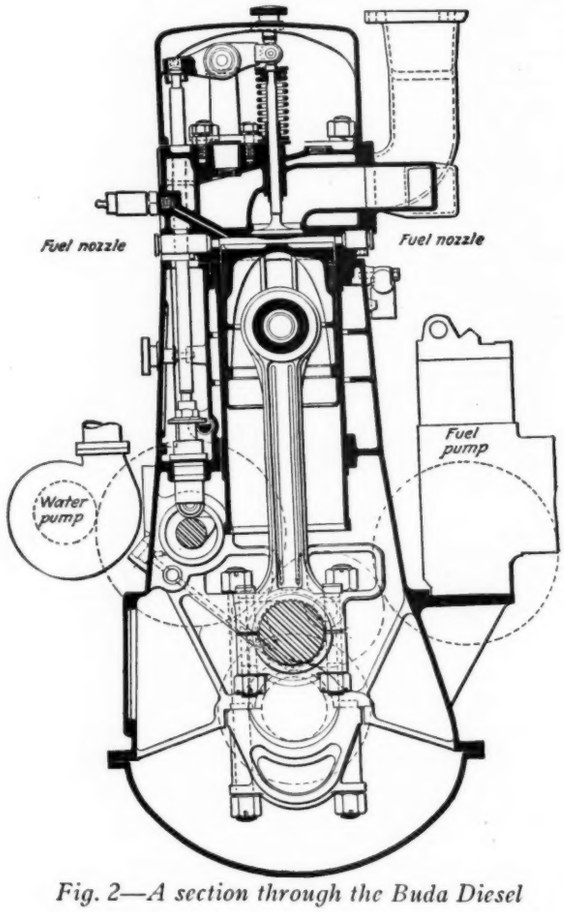


Fig. 2—A section through the Buda Diesel

on the flywheel housing, and the pressure pump forces it through the filter to the main and cam shaft bearings. From the main bearings it goes to the crankpins and up the drilled connecting rods to the wristpins. It is also forced to the rocker-arm assembly and to the fuel pump. The timing gears are lubricated by a jet of oil directed to each pair at the point where the gears mesh. The oil from the main bearings and all other moving parts drains to the bottom of the sump pan, from which the sump pump returns it through a screen to the supply tank. Mechanical lubrication of the pistons has also been provided for if desired. The constant oil pressure is maintained and protected by safety valves.

Careful consideration has been given to accessibility of all working parts for ease of inspection and servicing. The integral crankcase and cylinder housing, with walls between cylinders from top to bottom, give a rigid construction and permit the use of such thinner sections,

INTERNAL COMBUSTION *Engines*

which does much to decrease the weight of the engine.

The fuel pump is mounted on a bracket integral with the crankcase and is driven off the timing gear train. It is a cam-actuated plunger type, with a plunger and a cutoff valve for each engine cylinder. The cutoff valve and plunger are actuated by fulcrum tappets interposed between the main drive cams and the plunger and cutoff valve. The cutoff valve can be easily adjusted in the same manner as adjusting ordinary valve tappets. All moving parts are inclosed in a common housing and operated by one drive shaft having drive cams integral.

The engine speed is controlled by a governor built into the fuel pump and operating the cutoff valves, but these valves may be manually controlled if desired. The speed of the engine is increased or decreased by the point of the fuel cutoff and duration of injection, depending upon the plunger and valve position in relation to the piston position and speed. The two controls are the only ones for operating the engine and correspond closely to the spark and gas controls of the gasoline engine. The fuel-injection advance-lever location can be readily determined and arranged for a wide range of speed and the engine then controlled by the fuel cutoff lever the same as is done by the carburetor control lever on gasoline engines.

The fuel nozzles are of the open and solid injection type having one single opening and no spring-loaded check valve. This engine is adapted for connection to generators, pumps and other power consuming machinery.

Buying a Light Plant Out of Earnings

By G. Grow

IN 1923 the officials of Arlington, Ohio, decided to install a Diesel engine to meet a light and power demand that was beyond the capacity of the existing gas engine. Considering there were no funds in the treasury, their distribution system in a dilapidated condition and their average gross monthly revenue totaled only $270, it looked like a hopeless task.

After the village officials had visited several municipally owned Diesel power plants in Michigan, a proposition was submitted to them whereby the village could purchase a Diesel unit on terms that would enable it to pay for the machine out of the increased plant earnings. As a result the city purchased a 50-hp. generating unit from Fairbanks Morse & Company.

The 50-hp. unit supplied all the power save during a period between 7 and 10 o'clock in the evening, when part of the load was thrown on the old gas engine unit, which secured enough gas from the village gas well to operate it for this period.

In the summer of 1926 the load had increased considerably, the old gas engine was ready for the junk pile and the gas supply was nearly exhausted. It was then that the village purchased a 120-hp. Diesel generating set and changed the system over to 2,200-volt three-phase 60-cycle alternating current.

As the load continued to increase after the 120-hp. generating set was put in operation, the village officials purchased a 180-hp. Diesel set of the same make in the spring of 1927 and disposed of the old gas engine unit.

Since the first Diesel was installed, the average monthly revenue has increased 350 per cent—from $270 per month to $937 per month. Furthermore, the village paid for the first unit out of earnings and has been able to meet the obligations on the other units.

When the officials were contemplating the purchase of the first unit, they were under the impression that it would cost them $500 a month for an engineer's salary to operate the plant. To offset this argument the superintendent agreed to operate the plant and pay an engineer for a flat sum of $250 a month, which he has done since the purchase of the first unit.

Owing to the size of the engines and the fact that they can be operated in parallel, their load factor is very high for a municipal power plant. The plant records show that the fuel and lubricating oil costs of producing power is 9.68 cents per kilowatt-hour.

Indicating on Oil Engine

By John W. Morton*

NOW and then something irrational occurs in a power plant that sets the engineer guessing or wondering. Although the following happened on board a motorship, the principles involved apply to stationary power plants as well.

The chief engineer, at certain predetermined intervals of time, took indicator diagrams of his oil engines in order to determine the horsepower as well as the valve setting. The engines performed in a satisfactory manner, and the diagrams were as fine as one could desire.

One day, however, the indicator, the only one on board, broke, and was returned to the manufacturer for repair. In order not to be without an indicator on the next long voyage, one of a different make was borrowed. Great was the engineer's surprise, though, when comparing the old and new diagrams to find that not only was the horsepower not the same, but the combustion peak was altogether different. As everything else was equal on the engine and no change whatsoever had been made on the indicator rig, it is evidently a case of difference in the recording mechanism of the two makes of indicators.

Such local faults as a dry indicator piston, inertia effect, too tight or too loose a spring, etc., cannot be remedied, to reproduce or duplicate what the engineer thinks is an absolute bona fide indicator diagram.

In relating this little incident, the purpose is to focus operating engineer's attention upon the fact that no two indicators of different makes can be trusted and, therefore, great care should be taken in adjusting an oil engine, based on information revealed by the indicator diagram after the erection and preliminary runs. Readjustment and rechecking must, of course, be made from time to time to correct for wear of the running parts.

*Diesel Engineer, American Brown Boveri Co.

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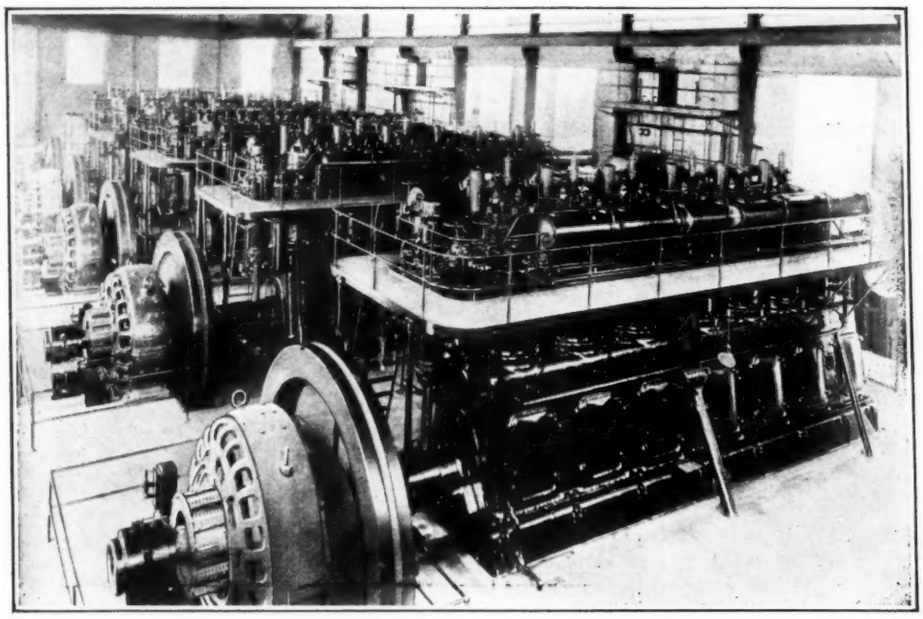

Five 750-kw. d.c. generators driven by Diesel engines

Operating Commutating-Pole

Generators in Parallel

By HENDLEY N. BLACKMON

General Engineer, Westinghouse Electric & Manufacturing Company

MODERN direct-current generators generally have commutating poles or, as they are frequently called, interpoles. Within certain limits the interpoles establish a fixed zone of commutation, which makes it unnecessary to shift the brushes with a change in load, as was required with the older types of machine. Commutating poles may have a material influence on the volt-ampere curve of a generator, and successful parallel operation will be likewise affected.

Direct-current machines generate alternating current in the armature coils. The commutator mechanically reverses the coil leads to the outside load at the same instant the current in the armature coils reverses. This reversal of load current, in the coil being commutated, creates a reactance voltage within the coil. The interpole neutralizes the influence of armature reaction in the commutating zone and also provides a commutating flux to assist the current reversal in the armature coils. Reactance voltage is proportional to the armature's speed, the number of turns short-circuited during commutation, and the load current. Since the first two factors are constant, the reactance volts vary directly as the load current.

The interpole windings carry load current, but the commutating flux produced by these windings is not directly proportional to the current, as is the reactance voltage. At only certain values of load current is the interpole flux of a correct value. At points below this an excess commutating flux is present, causing local currents to flow in the armature coils and brush faces. At points above, the reactance flux of the armature will be stronger than the interpole flux, and circulating local currents will be produced in a direction opposite to those below the load point to give correct interpole flux. These local currents vary directly as the amount of excess flux and inversely as the resistance of the path.

Over-compensation causes the circulating current to produce a flux which strengthens the main-pole flux. However, the volts drop due to the resistance of the armature winding and the armature reaction usually is greater than the increase in volts due to this strengthening of the main poles, and the dropping characteristic is

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retained. The tendency of over-compensation is to cause compounding action. Under-compensation creates a demagnetizing flux which bucks the main field. Therefore, this effect is to produce drooping tendencies and is not detrimental to parallel operation.

It must be remembered that the commutating zone

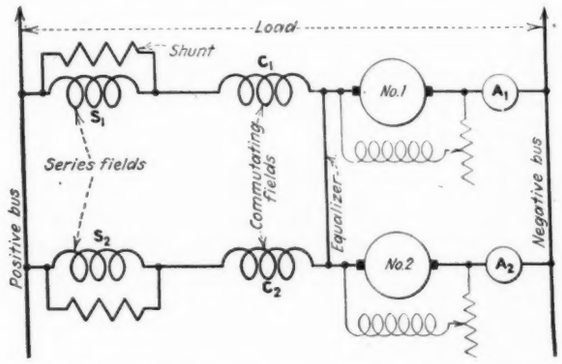

Fig. 1—Two commutating-pole compound generators in parallel, with equalizer in the wrong position

moves with the brushes. If the brushes are given a back lead, the commutating poles assist their neighboring main poles of the same polarity. This action approaches that of a series field, since the interpole flux varies as the load current. A rising, and therefore objectionable, armature characteristic is produced. A forward brush lead causes a demagnetizing effect on the main poles. This is comparable to having a differential series winding and assists the stability of multiple operation. However, commutating poles are primarily for commutation and the brushes should remain on the neutral position.

Shunt machines, with or without interpoles, may be

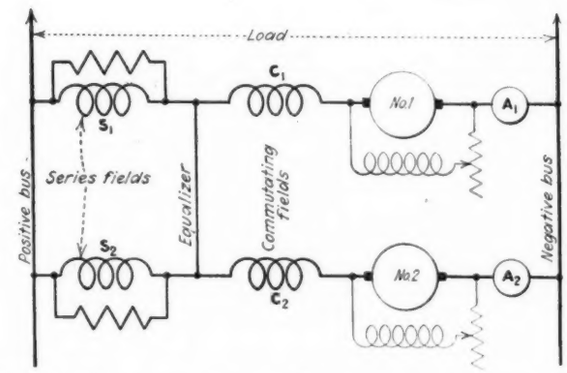

Fig. 2—Two commutating-pole compound generators in parallel with equalizer in the correct position

made to operate satisfactorily in the same manner described in the Jan. 17 issue, page 107.

Compound machines are not vitally affected if the brushes remain on the neutral plane. The commutating winding should be considered as part of the armature, when connecting in an equalizer. If the equalizer was placed as shown in Fig. 1, the current flowing through the commutating winding would be different from its respective armature current, whenever the equalizer carried corrective amperes. Fig. 2 is the correct connection, since the same amperes flow through the interpole winding as through the armature.

Summarizing the parallel operation of shunt or compound machines with interpoles, it may be said that:

1. With the brushes set on the neutral the conditions for shunt-machine parallel operation remain as for non-interpole machines.
2. With the brushes on the neutral of compound generators the additional requirement to those previously given in the Feb. 21 issue, page 332, is that the equalizer lead must be connected outside the interpole winding.
3. A brush lead against rotation tends to raise the voltage with increased load.
4. Brush lead in the direction of rotation tends to lower the voltage with increased load.

Machines with Compensating Windings

Many commercial machines are provided with compensating winding in the polefaces, to permit better commutation with heavy overloads. The hump in the

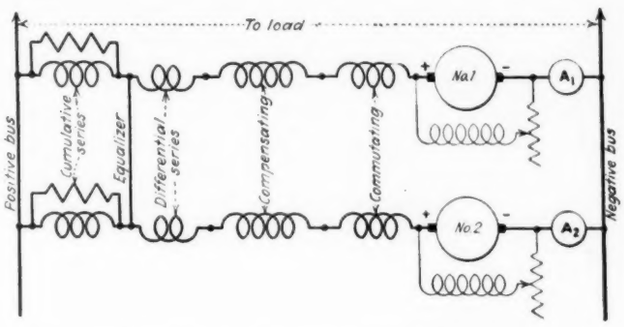

Fig. 3—Diagram of two compensated-type compound generators in parallel

volt-ampere relation of generators may be removed by eliminating armature reaction. Compensating windings carry armature current and are so connected and distributed in the polefaces of the main field poles as practically to neutralize armature reaction. Such machines inherently give almost flat armature regulation. This introduces paralleling difficulties, since the armature voltage droop has been largely eliminated. The series field now acts to produce practically constant voltage from no load to full load. In other words, the machine has been robbed of the greater portion of the inherent voltage droop, even at the equalizer terminals.

Machines of this type, if designed for parallel operation, are often equipped with a few series turns on the main poles to provide a differential series field in addition to the cumulative series turns, the net strength derived being the difference between the two opposing windings. The equalizer is placed next to the cumulative series winding, as in Fig. 3, so that the differential series turns are arranged to carry only the current output of their own armature.

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Suppose unit No. 1 momentarily carries more load. All the current from the machine flows through the differential series field and then divides at the equalizer. Only a portion of this current energizes the cumulative series field of No. 1, and the series field of No. 2 is correspondingly strengthened. Since the difference in ampere-turns between the series and differential winding

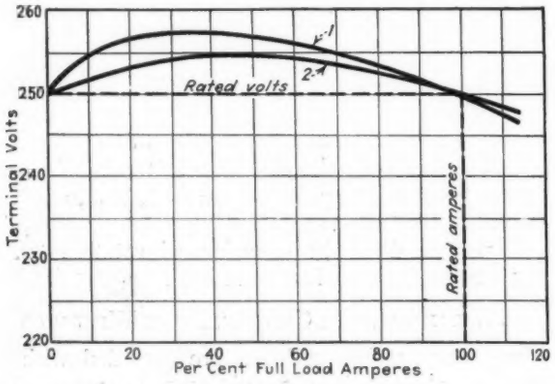

Fig. 4—Voltage curves of two generators that have equal voltages at no load and at full load

of unit No. 1 has been reduced and that of unit No. 2 increased, machine No. 2 will pick up load and No. 1 will release some. Thus the generators have a drooping voltage characteristic at the equalizer.

With compensated machines having no differential series winding, stability in parallel operation may be produced by a shift of the brushes in the direction of rotation. This method should be used, however, only as a last resort.

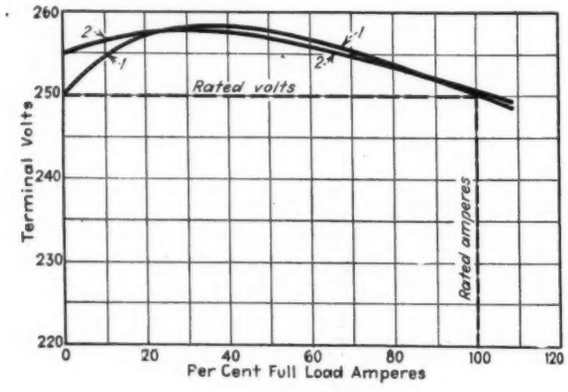

Fig. 5—Same as Fig. 4, but equal voltages occur at one-third and full load

A summary of requirements for operating shunt- or compound-compensated machines in parallel shows:

1. Conditions previously stated apply to shunt machines.

2. The equalizer lead between compound machines must be placed outside the compensating and differential series field windings.

When adjusting machines for parallel operation where the station load does not fluctuate rapidly, it is recommended that the voltage be the same at one-third load and full-load amperes. This precaution serves to place the usual load range on the more similar parts of the two regulation curves. Two machines of different ratings may have decidedly similar humps in their volt-amperes curves in spite of all adjustments. Making the voltage the same at one-third and full voltage will materially assist toward proper load divisions. The curves Figs. 4 and 5 show the results of two different adjustments.

In Fig. 4 the voltages of the two machines are equal at no load and at full load, whereas in Fig. 5 these equalities occur at about one-third and at full load. In the former the load will divide in the proper proportions between the two machines at full load and at no load,

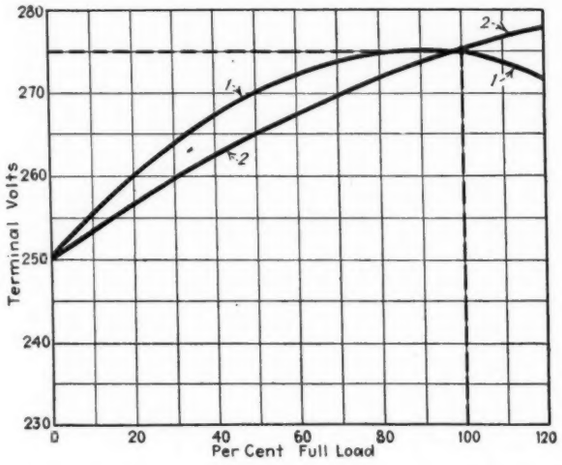

Fig. 6—Voltage curves of two over-compounded machines that have equal voltages at no load and at full load

whereas, in the latter these divisions occur at one-third and at full load. Between the one-third and full-load points, Fig. 5, the curves are much closer together than they are in Fig. 4, therefore the Fig. 5 adjustment will give better load division than will be obtained with the voltage adjustment in Fig. 4.

A great many loads fluctuate rapidly, such as railway and steel-mill power demands. A load of this nature necessarily requires the no-load voltage of all machines to be approximately the same. If operating as in Fig. 5 during light load periods, unit No. 1 will take reversed armature current and will be removed from the bus by the reverse-current protective relay. Full-load reappearing will be excessive for unit No. 2, and this generator will shut down owing to overload. Consequently, with widely fluctuating demands system stability may be obtained only by operating as in Fig. 4.

Effect of Speed Variations

For any given load the speed of the generator must remain constant, a condition which is, of course, realized in the case of synchronous motor-generator sets operating

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on the same alternating-current system. Engine-driven units, especially single-cylinder prime movers, make successful parallel operation difficult. The variation of speed within a single revolution causes the load to surge and requires careful adjustment to insure stability.

The proper speed setting of two generators in parallel may often be used to improve their performance. Fig. 6 shows typical volt-ampere curves of machines supplying a common load. Each carries correct load at 100 per cent rating, but unequal division exists at all other points. Increasing the speed of unit No. 1 allows it to work with a weaker field and, therefore, lower on the saturation curve. Reducing the speed of unit No. 2 requires stronger excitation, causing the machine to work at higher saturation. Both adjustments are corrective in action.

Shunt Machines Simplify the Problem of Parallel Operation

The use of shunt machines materially simplifies the problem of parallel operation, except where the machines are fundamentally different in their design characteristics. In the case of dissimilar machines, as for example, compensated and uncompensated generators operating on the same direct-current bus, a compound winding is useful in that it provides a means for matching the slopes of the various machines' characteristics. In any case a drooping characteristic of at least 5 per cent at the bus will prove effective in obtaining satisfactory parallel operation, when compared to a flat regulation characteristic.

The extensive use of compound machines in the past has been an effort to provide automatically approximately constant voltage at the load. Parallel operation was accomplished through more or less frequent adjustment of the shunt-field rheostats by the station operator. In Edison systems, where constant voltage at the load centers is essential to good service because of the lighting load, it is impracticable to maintain the voltage within sufficiently close limits by means of compound windings on the machines. On such systems it is customary to use shunt machines under either manual or automatic voltage-regulator control.

Studies Made of Conversion Equipment

Coincident with the development and establishing of the automatic substation in the field of direct-current distribution, a large number of studies have been made, covering all classes of service, for the purpose of properly co-ordinating the conversion equipment, the distribution system and the load. It has been found, in most cases, that little real operating benefit is to be derived from the use of compound machines, whereas the inherent droop in the shunt machine presents numerous advantages. Benefits are realized in better division of load between stations, system stability at both light and heavy loads, better parallel operation of machines on a common bus, and wider choice of substation location with respect to fixed load centers, which in some cases effect a considerable reduction in the losses in the distribution system.

A New One in Motor Troubles

Thomas A. Brown

TROUBLES have developed in electric motors from practically every conceivable cause, but to have a three-foot snake cause a burnout is probably a new one. Recently, a split-phase motor used to drive a pump failed to come up to full speed and upon investigation the starting winding was found roasted out. The motor was

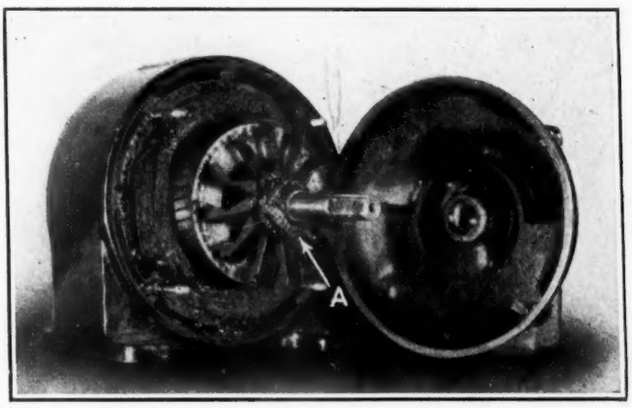


Fig. 1—Snake shown on the rotor shaft at A

removed for repairs, and when it was taken apart the cause of the trouble was discovered.

At *A* in Fig. 1 can be seen a snake wound around the rotor shaft and the automatic switch used to cut out the starting winding when the rotor reaches near full speed. It was wound in such a way that this switch could not open, and the motor operated with the starting winding in circuit until this winding burned out.

In Fig. 2 the snake has been moved out along the shaft from the switch, but it still remains in a tight coil and was removed this way from the shaft. The motor

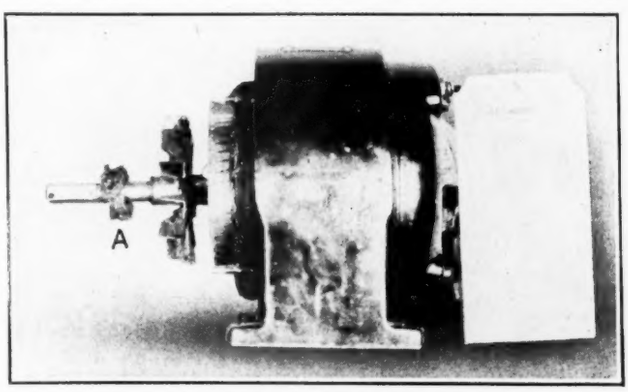


Fig. 2—Automatic switch and snake moved out from the rotor

was in an open-type mill building, and it is assumed that the snake entered the building and accidentally came near the motor and, finding it nice and warm, decided it was a comfortable place to select for a home, but this proved to be a fatal decision.

EDITORIALS

A Tribute to the Engineering Method

IT IS often said that fewer lawyers and more engineers in Congress would make for less debate and greater achievement. Not that engineers as a class possess a monopoly of "gray matter," nor are they endowed with any remarkable degree of legislative ability, but it is quite apparent that a large proportion of our public problems are susceptible to engineering methods of analysis.

Engineers are successfully administering the affairs of several of our large cities, as city managers, and some people like to predict that the time is not far distant when an engineer will administer the affairs of the nation. Recent developments give weight to such a prediction.

Irrespective of party affiliations the engineering fraternity must take pride in that one of its outstanding members looms strongly as a Presidential candidate, solely upon his record and in spite of certain political groups. In reorganizing the Department of Commerce into a helpful service to American industry, in directing flood and famine relief and serving on various special commissions, Herbert Hoover has ever applied that kind of constructive thinking for which his training as an engineer has so well fitted him. The results bear witness to the methods.

Whether Mr. Hoover be successful in being chosen as the candidate of his party, or later, as President in the November elections, will not detract from the fact that recognition of engineering method and accomplishment has been reflected in the very substantial support accorded his candidacy.

Logical Procedure in Selecting Motors

FIRE destroyed the greater part of a large manufacturing plant and a consulting engineer was called in to lay out, construct and install new buildings and equipment. In discussing this new plant, two conditions were established by the manufacturers' representatives for the engineer's guidance: The factory manager was to make all the decisions as to the new production equipment purchased; and the power engineer was to determine all power applications and select all motors.

The reasons given to the consulting engineer for this last condition are of particular interest to all industrial plants operating a large number of electric motors. In the plant that had burned, there had been as many as ten different makers represented in a total of three hundred and eighty odd motors. The problem of maintenance, particularly as to repair parts carried in stock, to accommodate all these varied motor designs, was difficult and confusing. It had, therefore, been decided that the power engineer was to select all the motors for the new plant. The maintenance of these motors after installation was one of the power engineer's duties. Understanding the requirements, in labor and supplies, for this maintenance, both in the production departments and in the power plant, he was the one man in the plant best fitted to select these motors so that his whole maintenance problem would be simplified and cheapened. Being also responsible for power generation and application, he could be counted upon to see that the motors selected were the right motors for the work to be done in each case.

Of course there are many other plants where the power engineer selects the motors. It seems to be such a logical procedure that the wonder is that it is not standard practice in all plants. Economies from the standardization of equipment to a few sizes and makes are the usual thing with production machinery. Similar standardizaton of motors, under the man in the plant who best understands motors, the power engineer, is at least as much of a forward step. It results in economies that no plant can afford to disregard.

Heat Transfer in Closed Heaters

THE regenerative cycle employing steam bled from points on the main turbine to heat the feed water is a development in this country of the last ten years. At the present time it is quite universally adopted for all new installations. When the early plants were being designed, there was much debate concerning the rates of heat transfer in bleeder heaters. Many believed that superheated steam should not be admitted directly to the heaters, but should first be desuperheated. Experience has shown that the latter operation was not necessary, and steam at any temperature or quality is now delivered to these heaters. Much has been learned regarding the best methods of draining heaters when in cascade, and also of venting them.

One finds much carelessness in many plants with regard to vents between heaters. These usually consist of pipes of reasonable size provided with a hand-controlled valve which is supposed to be adjusted by the

operator to allow the gases from the heater to vent to a chamber at lower pressure. For best results it is obvious that the adjustment of this valve should be modified with changing loads on the main unit. Usually, no such adjustment is made and the valve remains in the position judged best for its worst operating condition. Often this means that the valve remains wide open at all times, bypassing large quantities of steam to the next lower heater. Some automatic form of control valve, such as used on house radiators, should be developed, that will pass only air and gases but not steam. This would effect an appreciable saving in many plants.

Closed heaters operate with distilled water on one side of the tubes and steam on the other. Transfer rates should be high under these conditions. Furthermore, it should be easy to determine these rates by test when temperatures are measured with proper accuracy. Yet very few have been published on these rates. If more of this information were available, these heaters could be designed more accurately and their performance checked more intelligently. This suggests a proper subject for investigation and report.

Steam reheaters have been suggested for high-pressure steam turbines. Reheated steam is necessarily superheated steam. What rates of transfer occur in such reheaters? These also would prove interesting and valuable data.

Home-Made Repair Parts

THERE is a strong temptation to make up repair parts for plant equipment, either in the user's own shop or in a jobbing shop around the corner. In emergency this practice is not seriously questioned, but there are good reasons why it may be bad as a regular practice.

When the user buys something from a reputable manufacturer, he pays not alone for mere metal and labor, but also for experience and skill and grief of days gone by. And when the manufacturer delivers his product to the buyer, he does more—he stakes his reputation on the successful performance of the product in the hands of the user. If the machine works well, the manufacturer is credited with a good job. If it fails, he suffers in the opinion of all who hear about it, whether they hear all the truth or only a mixture of little truth and much error. With everything that he sells, the manufacturer gives hostages to fortune and the user of his product is the custodian of those hostages.

Is there not a moral obligation assumed by the purchaser to refrain from anything that will tend to impair the successful operation of a machine?

Home-made repair parts are often inferior in material and workmanship to those made by the manufacturer. The original dimensions have been altered by wear and tear. The material used by the manufacturer, in some cases specially selected for suitability to the task, is not known to the user who is making his own repair parts out of some handy bit of steel or some readily obtainable grade of cast iron.

The manufacturer spends much money and effort to develop his product, and he often finds that success hinges upon inconspicuous details of design, or on the choice of special materials, or on high standards of workmanship. Doubtless many a machine has certain vital parts that involve elements in their design or manufacture that are far from evident on the surface.

In some cases, let it be admitted, the home-made repair part is every bit as good as parts made by the manufacturer, but it is certain that in other cases this is not at all true. Who can tell which is which?

If the home-made job is inferior, machine service is sure to be impaired, and if the practice of fixing things locally is general, persistent difficulty is probable, and those who know only part of the story will naturally think ill of the equipment as a whole.

One of the best things about poorly made repair parts is that their comparatively miserable performance teaches their maker how careful he should be in future to secure appropriate parts from the manufacturer.

Repair parts cannot be secured from the manufacturer fast enough in an emergency? Don't be too sure. And anyway, why wait for an emergency? A man of experience can pick out key parts of a machine that are likely to wear or are subjected to heavy load, and these can be backed up by spares, bought perhaps with the machine in the first place. Probably they can never be bought more easily or at a lower price.

It cannot be denied that there is another side to this matter. Sometimes the manufacturer, beset with a demand for low prices, makes parts that are not all that they should be, and some well-equipped user can readily make parts of better material, and perhaps with better workmanship, to improve the machine. Sometimes this is done by users whose service is unusually severe or otherwise different from the work for which the machine was designed. Again, it must be admitted that the prices asked by the manufacturer for spare parts are sometimes higher than the cost of having apparently similar parts made nearer home. Here also, the manufacturer must be paid for brains as well as for metal. Is the user perfectly square who takes advantage of the manufacturer by copying parts developed only at great expense?

There are those to whom an appeal to fair play and an allegation of moral obligations does not appeal strongly. Let them be reminded that it is worth real money to have a repair part really fit and work and keep at it. Interruptions are costly—much more costly than doing the job right the first time.

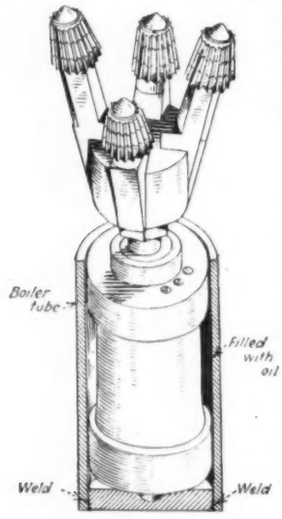
Somebody must pay for experience and brains and skill. Somebody always pays for inferior service. Pay you must. Be sure to get real value for your money.

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Holder for Tube Cleaner Made from Piece of Boiler Tube

SOME manufacturers of boiler-tube cleaners advise tha tthe cleaners be kept in oil when not in use. We endeavored to do this, but generally found that the oil bucket supposedly containing the tube cleaner usually contained an assortment of nondescript articles as well, or else it was practically empty of oil.



Tube cleaner holder

In order to insure the cleaner's being properly immersed, we took a piece of an old boiler tube that was slightly longer than the cleaner and welded a cap on the bottom. The cleaner was then placed inside and covered with oil. We found that this bath could be easily stowed in the tool locker and nothing else could be put into the container with the cleaner.

By keeping the cleaner immersed in oil, it is ready for use at any time and the parts are kept free of rust and corrosion. R. G. EDWARDS.

Port Arthur, Ont. Canada.

Flashlight Finds Heat Leaks in Steam Pipe Insulation

ONE of the troublesome jobs in a power plant is that of locating heat leaks in insulated high-pressure steam lines installed high above the floor. In our plant there is considerable vibration from the machinery overhead, and the insulation cracks rather frequently. This of course necessitates inspections at rather short intervals, which task is generally carried out with the aid of a step-ladder.

To simplify this work, we devised a new method that enables us to find the leaks in a few minutes, without the use of a ladder. A flashlight is employed, with its lens removed and the curved mirror shut off by a disk of black cardboard, so the bulb alone shows.

Streams of heated air, issuing from cracks, are considerably less than the surrounding atmosphere. Therefore they refract light rays much less, and when light from a point source falls on them, they throw dancing, shimmering shadows. The intensity of shadows, it seems, is about proportional to amount of heat dissipated. Thus every crack or defect in the insulation is noticeably marked by a stronger shimmering display and can be almost instantly located.

There are many plants, to be sure, where steam lines are more conveniently installed and even wrapped with sailcloth or heavy cotton to prevent cracks, but that is not the case in our plant.

A thorough study of heat currents in general, may be carried out with an apparatus slightly more pretentious than the humble flashlight. A carbon arc is so sensitive that it will throw clear shadow pictures of warm air currents that rise from a human hand.

LEON J. ISRAILEVICH.

Leningrad, Russia.

Tabulation—an Aid in Selecting Equipment

THE primary purpose of tabulation for equipment selection is to present a summary of all the facts contained in the proposals submitted by manufacturers. From this summarization a clear view can usually be had of the entire situation and differences in details quickly noted. Also price, which is a poor economy index, receives last consideration, while the individual features of each manufacturer's unit get the greatest attention.

Proposals may be submitted in several forms and vary as to contents. Some are simply letters giving only essentials, while others are in the form of folder-booklets. This latter type contains detailed specifications of the equipment and is supplemented by additional notes to meet any special requirements of the case. The tabulation is begun after all proposals have been received.

PREPARING TABULATION SHEET

The first step in preparing the "tab" sheet is to select suitable headings under which the entire data of all proposals may be logically grouped. This is accomplished by glancing through each proposal and making a list of all main subjects which would have a bearing on the selection. The subjects are then arranged in tabular form with a vertical column headed by each. Typical data obtained from numerous proposals are given in Table I. Horizontal columns on the sheet are made for each of the bidders.

The sheet is now ready for filling in the specification notes, which is done by carefully reading each proposal and noting the data under the proper heading and opposite the particular manufacturer's name. These notes

should be clear and brief. Table II shows a completed tabulation sheet. A picture is thus presented comparing the several makes of equipment on the basis of common details. A quick review will enable the engineer to see if further data are necessary before final selection.

Scoring Method for Selection

With the tabulation completed there are two ways in which selection can be made. The first is by reviewing the "tab" sheet and keeping in mind the salient features of the different bids as an entirety. Then the bid that seems best is accepted. The second and more reliable way consists of numerically valuating or scoring in their order of merit, each detail listed under the same column heading for the various bidders, thus selecting the best of each column before considering the next. The summation of these individual column scores gives the rating of any particular machine as a whole compared to the others.

TABLE I—TYPICAL COLUMN HEADINGS FOR TABULATING MECHANICAL EQUIPMENT PROPOSALS

Centrifugal Pumps		Ash Hoppers	
Col. No.	Headings	Col. No.	Headings
1.	Contractor's Name	1.	Contractor's Name
2.	Date and proposal No.	2.	Date and proposal No.
3.	No. of pumps required	3.	No. of gates required
4.	General type of pump	4.	General type
5.	Discharge capacity, g.p.m.	5.	Capacity of each hopper
6.	Discharge head, ft.	6.	Material of hopper
7.	Suction lift, ft.	7.	Min. angle of hopper
8.	Efficiency	8.	Clearance for ash cars
9.	Brake horsepower	9.	Type of lining
10.	Speed, r.p.m.	10.	Ash gates, type
11.	Kw. required	11.	Ash gates, size
12.	Size of suction	12.	Ash gates, material
13.	Size of discharge	13.	Rollers, size and material
14.	Suction, double or single	14.	Size of rail
15.	Will motor be furnished?	15.	Dust gates, type
16.	Casing, type	16.	Dust gates, operation
17.	Casing, material	17.	Type and No. of quenchers
18.	Impellers, type	18.	Water required
19.	Impellers, material	19.	Operating machinery
20.	Impellers, passages	20.	Type of control
21.	Impellers, leakage prevention	21.	Gear shift
22.	Shaft, size	22.	Pump, type
23.	Shaft, material	23.	Pump, size
24.	Shaft, sleeves	24.	Pump, motor
25.	Shaft, stuffing boxes	25.	Type of pressure tank
26.	Bearings, type	26.	Size of pressure tank
27.	Bearings, material	27.	Capacity, of pressure tank
28.	Coupling, type	28.	Will contr. furnish Alemite gun and fittings?
29.	Bedplate, material	29.	Steel supports by whom
30.	Guarantee	30.	Painted by whom
31.	Weight of pump	31.	Will contr. erect?
32.	Delivery time	32.	Guarantee
33.	Price	33.	Time of completion
34.	Freight charges	34.	Shipping weight
35.	Remarks	35.	Price, furnished
		36.	Price, erected
		37.	Freight charges
		38.	Remarks

The procedure of scoring begins by noting the columns in which the bids differ. These columns are then assigned values, on the basis of a 100 per cent total, proportionate to their relative importance to the entire equipment. Now each column is individually considered and the different details of each manufacturer given a score, according to the desirability of the detail with the best receiving the value assigned to that column as the highest. The others would then get values in proportion to the best. The column scores are then added horizontally for each bidder's equipment. The highest total score would thus indicate the unit ordinarily most desirable. Prices could then be compared to see if the difference in cost between any machines was offset by greater desirability.

This method of selection, as in the case of any other, cannot be better than the judgment and experience of the engineer using it, but certainly encourages thoroughness in analysis.

R. T. Regester.

Columbus, Ohio.

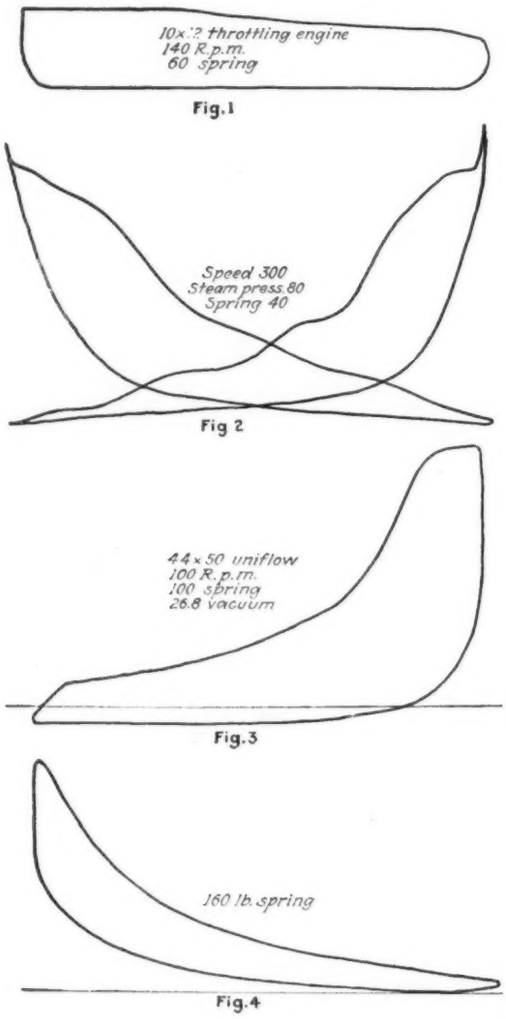
TABLE II—TABULATION OF QUOTATIONS COVERING ONE 3-TON MONORAIL TROLLEY CRANE

Contractor	Date and Prop. No.	Type	Cap. Lb.	Lift, Ft.	Speeds, Ft. Per Min. for Full Loading			Runway Beam	Wheel Base and Load per Truck	Motors and Control	Voltage	Cage Type	Hoists	Sheaves	Trolley Wheels	Trolley Frame	Gears and Pinions	Delivery	Price F.O.B. Purchase
					Main Hoist	Closing Hoist	Trolley												
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
"A" Co.	May 11 No. 2457	3-motor I-beam hoist, bucket handling	6,000	25	50	50	200	18 in. I 49 lb. Beth.	9 ft. 6 in.	Fur. by Pur. erect. by Contr.	220 d. c.	Encl. on trolley	Sta. C. I. Double 90° to track dyn. control	Steel	Cast. stl., single flange	Str. steel	Not given	90 days	$3,560
"B" Co.	May 28 No. 1189	3-motor I-beam hoist, bucket handling	6,000	26	107	.....	370	18 in. I 49 lb. Beth.	7 ft 11,000 lb.	ditto	220 d. c.	Encl. on trolley, all steel	Sta. 14 in. drums dyn.	.....	Cast stl. hollow, self oiling	Cast steel	Forged stl. pin., cast. stl. gears, cut teeth	8 wks.	$3,850
"C" Co.	May 14 No. 2505	2-motor, one op. hoist and closing lines, dir. geared. No friction clutches	6,000 (1 cu.yd. bucket and 2,200 lb. of scale.)	.....	75	.....	200	.....	10 ft	ditto	.....	Encl. on trolley	Sta. 2 drum 90° to track, dyn.	.....	Steel, 2 per truck	Str. steel	ditto	90 days	$3,710
"D" Co.	May 13 No. 383	3-motor I-beam hoist, bucket handling	6,000	30	60	60	250	20 in. I Beth.	13 ft. 2 in. 11,600 lb. rear 8,400 lb. front	ditto	220 d. c.	Encl. on trolley, steel sash	Sta. double gear train 16-in. drum	.....	Cast-iron shrunk steel tire	ditto	ditto	8 to 10 wks.	$4,235

COMMENTS *from* READERS

Why Compression Is Necessary

REFERRING to the letter by C. E. Sargent in the Nov. 1, 1927, issue, on "Why Compression Is Necessary," I would suggest that if he wishes further practical demonstration of the forces of inertia in an engine which is arrested by compression, he might go to a forge shop where there is a steam hammer and have



Figs. 1 to 4—Some interesting indicator diagrams

the operator put the hammer into operation with as long a stroke as convenient without striking the anvil or the buffers above, and he will see just what is done in a steam-engine cylinder in addition to developing the full power, to be taken off at shaft or piston rod extension of the engine, as the case may be.

There are still in service in the Cleveland, Youngstown and Pittsburgh districts many steam engines that will not "run without compression and without pound."

The inclosed cards are old ones picked up on my travels. The one shown in Fig. 1 is from an engine that has since been replaced by a motor because it pounded so badly it could be heard all over the place. The others show different conditions and service, but good compression and quiet running. Fig. 4 shows good compression up to the power stroke. D. P. TOLTON.

Lakewood, Ohio.

* * * *

Combustion Control Formulas

IN THE Feb. 21 issue of *Power* Mr. Uehling refers to the steam-flow air-flow method as a "synthetic method of combustion control."

In the first place, "combustion control" is not, in my opinion, the correct term to apply to CO_2 recorders, steam-flow air-flow meters, or other indicating and recording devices that show operating conditions without actually operating a mechanical control device to maintain proper combustion conditions. Combustion control is usually applied to the mechanism operated in response to changes in steam pressure, furnace draft, steam-flow air-flow, or other factors to bring about the proper results; while any of these results indicated on an instrument leave the control in the hands of the operator. We do not speak of a steam pressure gage as a "pressure control."

I am still further at a loss to know why Mr. Uehling refers to the steam-flow air-flow as a "synthetic method." It is certainly far more direct to measure actually the quantity of air used for combustion, or its equivalent, the products of combustion as they pass through the boiler passes, than it is to arrive at an approximate measure of the excess air through the indirect method of CO_2. A steam-flow meter shows what the boiler is doing. In normal operation the feed water temperature, steam pressure and other factors that measure heat input per pound of steam are constant or vary closely with the rating. The steam-flow meter is, therefore, a reliable guide of heat absorbed from the furnace.

When combustion is completed with the desired excess air, there is a coincidence of readings between a steam-flow meter and an air-flow meter with the pens arranged to travel over a single record.

The differential pressure across certain passes of the boiler that are free from variable resistance due to slagging, etc., has proved to be an accurate measure of the relative quantity of air used for combustion.

Mr. Uehling has clouded the issue by figuring out B.t.u. per pound of air for several different classes of fuel. He has not given the analyses of the fuels used, nor stated on what basis the carbon-available hydrogen relation is to be applied in the formula. Therefore I am unable to check his calculations. However, he entirely

misses one very important point, which was fully explained in a paper presented before the American Society of Mechanical Engineers and reprinted in *Mechanical Engineering* of July, 1926. I refer to the air-flow measurement as giving a reading based upon flow effect rather than upon quantity of air alone. I therefore submit the following table showing B.t.u. per pound of air as given in Mr. Uehling's article, also the relative flow effect of these different fuels per B.t.u. for a standard of 30 per cent excess air.

	B.t.u. per Lb. Air as Given by Uehling	Flow Effect per B.t.u. for 30 Per Cent Excess Air	CO_2 for 30 Per Cent Excess Air	Excess Air for 14 Per Cent CO_2
Anthracite	1,310	130	15.2	40
Semi-bituminous	1,347	129	14.3	32
Bituminous	1,356	129	14.3	32
Sub-bituminous	1,344	129	....	..
Fuel oil	1,500	127	11.7	9
Natural gas	1,800	121	8.8	Impossible

It is noted that on the basis of flow effect per B.t.u. there is less than 9 per cent difference between anthracite and natural gas, while Mr. Uehling erroneously gives the impression that there is more than 30 per cent difference. It is noted that outside of natural gas the difference between anthracite and all grades of bituminous coal, including fuel oil, is about 2 per cent, which is closer than anyone can hope to maintain excess air.

The table also shows the variations in the percentage of CO_2 for the same excess air on the different fuels mentioned by Mr. Uehling; or, on another basis, if a man were striving for a constant percentage of CO_2, the variations in excess air he would have for the different fuels.

Mr. Uehling has given several objections to the steam-flow air-flow method in comparison with the analytical. Among them he states as a disadvantage the need for actual test to be made with some skill and intelligence to determine the most efficient steam-flow air-flow relation. May I say that this same test should be made before establishing a standard to follow with the use of CO_2 recorders or any other combustion guide?

He has further confused the term maximum combustion efficiency with the theoretical excess air. If steam-flow air-flow were set for exactly theoretical excess air, then a deficiency in air would leave the steam-flow reading higher than the air-flow. However, in actual practice there are few cases where it is justifiable to establish a standard excess air of less than 10 per cent, and mostly 20 per cent to 30 per cent is the standard for the majority of furnaces, and with an established standard there is no difficulty whatever from the imaginary points that Mr. Uehling has raised.

The best way to determine any quantity is to measure the thing itself. This is done in the steam-flow air-flow method. The next best is to measure indirectly, as by gas analysis, and in this respect the oxygen would be much better to record and indicate in waste flue gases than is the percentage of CO_2. Oxygen is difficult to determine commercially, therefore most manufacturers have been content to drop back to third place and use the CO_2 as an indirect guide for combustion efficiency.

Mr. Uehling states that steam-flow air-flow does not record data that will aid in calculating the heat losses up the chimney. May I refer Mr. Uehling or other interested readers to a bulletin issued by the Bailey Meter Company, which explains how air-flow steam-flow indications can be used to calculate heat losses?

Mr. Uehling terminates his series of articles by saying: "Notwithstanding good results obtained by steam-flow air-flow method, there is no doubt that the operating efficiency could be materially bettered by adding a combined CO and CO_2 recorder to the equipment." There may not be any doubt in Mr. Uehling's mind on this point, as he is not personally operating boilers today, but a visit to the power stations of this country will, I am sure, convince him that many engineers and operators do not fully agree with him on this point.

F. G. BAILEY, *President,*
Bailey Meter Company.

Cleveland, Ohio.

* * * *

Dissociation or Evaporation?

IT WOULD be well if consideration of the editorial, "Dissociation or Evaporation," in the issue of Jan. 24, precipitated attention to the available means for answering the question.

The editorial appeals directly to the physical chemist for information. This is an open acknowledgment, not yet sufficiently practiced, of the need of more direct co-operation between mechanical engineers and those following the science of physical chemistry. But the availability of knowledge from which to gather an answer deserves attention.

Before asking ourselves the question "Dissociation or Evaporation?" let us ask, What do we know about the science of vaporization?

Vaporization is a fundamental process, one of the oldest, one of the most common in engineering, yet, to my knowledge, there is not in the English language a book or printed article giving a careful analysis of the conditions tending to limit the rate of vaporization. That the rate of vaporization has its limiting conditions, seems reasonable.

At the outset there is the issue of careful definition; our question involves, probably, a worth-while distinction between evaporation and vaporization. Frequently, each is unwisely used synonymously. Vaporization is the more specific term; it is the more vigorous process; it develops a vapor pressure equal to the surrounding pressure; it refers to boiling. Evaporation is, to be distinctive, the slower process; it occurs in the drying up of pools and in the cooling of ponds; the vapor pressures developed are but a part of the surrounding pressure.

Consider a vaporization problem. Take a superheater. Given mist entering the superheater, how long should that mist remain in the presence of a given source of heat in order to vaporize? In short, for a given initial velocity of the wet steam, what phenomena determine how long the tube need be? In this connection equations for heat transfer are nearly all that we hear about, and these are here only distant relatives.

Or take another example. What do we need to know in order to tell how long lubricating oil particles will resist evaporation in a cylinder? Or still another example—a live one. How long will it take to vaporize fuel oil in an oil engine? We are in the dark concerning the scientific facts of vaporization, let alone operating information.

What, then, is the significance of this question "Dissociation or Evaporation?" In oil engine parlance we are probably asking ourselves, "Does water in passing through a boiler tube crack?" If it does, it is probably,

as suggested in the editorial, a surface phenomenon. If it is a surface phenomenon, why, in our present design, so much hole in the tube and so little surface? If it isn't a surface phenomenon, then we are still confronted with the question whether the conditions in a boiler tube as now provided meet the scientific requirements of high rates of vaporization.

We are into the field of the physicist and the thinker. What do we find? There is not in the English language a textbook of physics comprehensive enough to serve as a book of reference in an analysis of the limiting conditions in vaporization.

Here is one suggestion. Scientific development demands variation and latitude of thought. This suggests a need, not for means to yield a multiplicity of product, but of creative units. The minimum workable unit for scientific analysis is one mind and a book. There is at present, so I understand, work going on to standardize in this country the terminology and symbols in engineering thermodynamics. But the mechanical engineer is already groping in the field of physical chemistry. Efforts toward a common scientific language and alphabet wherever possible in our texts, should not be delayed.

Differences in scientific language may be just as serious a drawback as difference in racial language; they can obstruct mutual aid and make progress tortuous. Independent standardization, in each field, of terms and procedure, may tend to cause of itself an absence of understanding by scientists and engineers not only of each other's working knowledge, but of ability for mutual aid.

ROBERTSON MATTHEWS.

Detroit, Mich.

* * * *

Treatment of Boiler Feed Makeup

EVAPORATORS are becoming more in use in power plants for the purpose of furnishing pure distilled makeup feed to boilers. Feed water, otherwise obtained, contains substances such as carbonates, sulphates and chlorides of lime, magnesia, and sodium; iron and aluminum salts; silicates; minerals, organic acids and grease, which are injurious to boilers.

Since none but the volatile impurities pass out of the boilers with the steam, there is a continual concentration in the boilers of the impurities in the feed water. The non-volatile impurities remain in the boilers and cause corrosion, scale and increased density of the water. With pure distilled water these conditions are eliminated.

However, it must be kept in mind that in order to obtain the best results, the evaporators must be kept clean. If concentration becomes excessive, impurities are likely to be carried over. Precipitation of scale on the tubes will take place, and output will be cut down. It then becomes necessary to pull out the coils or tube nests and hand scale.

Experiments are being conducted in many power plants throughout the country by treating the evaporator feed water to prevent or soften the scale precipitation. As yet no particluar treatment has proved to correct these conditions in all plants, owing to the fact that the waters in different localities do not contain the same substances that tend to precipitate scale. Each plant will have to do its own experimenting and arrive at a treatment suited to its own particular case.

There are many types of evaporators and several methods of distilling water. The high-pressure submerged type is more in general use and is the type which scale adheres to the most, owing to the fact that high-pressure steam is used as the heating agent, giving a high temperature, which causes the scale to bake on the tubes, and generally it is a hard scale.

Low-pressure evaporation is supplanting high-pressure for several reasons. The first and most important one is that it permits the use of exhaust steam, which is generally available.

A second reason is, that a low-pressure plant (if properly designed and operated) will scale only to a slight degree in operation and as a result there will be no falling off in water production nor will the frequent scaling of tubes be required. The temperature corresponding to 10 lb. gage with saturated steam is 240 deg. F. It has been discovered that hard scale ceases to form at 265 deg. F. From this temperature down to 195 deg. F., a softer scale is formed. Consequently, if wet steam only, at a pressure not exceeding 10 lb., is used, hard scale is not formed. If the pressure is kept under 5 lb. and proper submergence of tubes is obtained, scaling is practically eliminated.

A third reason is that, by using a high vacuum, a large temperature range is obtained, permitting operation in multiple effect, either double, triple or quadruple, with consequent increase in economy. Multiplication of effects, however, does not correspondingly increase capacity.

The low-pressure evaporation principle is applied in two different ways. One involves the recirculation of the water in the evaporators in the form of a rain over the tube nest; the second involves the submerging of the tubes, and no special circulation is required.

Boston, Mass.

EARLE S. NASON,
Chief Machinist, U.S.N.

* * * *

Causes of Dangerous Boiler Deterioration

IN THE issue of Feb. 21, M. W. Bannister, commenting on my article in the Jan. 3 issue, asks why the sodium sulphate in the water softened by the lime-barium-carbonate process has not been changed.

In theory this should be changed into sodium carbonate, but actually the reaction does not take place because the water remains in contact with the barium carbonate only a very short time. This time is sufficient for calcium and magnesium sulphate, but not for sodium sulphate to be reacted upon.

It must be remembered that the barium carbonate does not go into solution and that, therefore, the water is in contact only during the time that it actually passes through the undissolved material. Consequently, any sodium sulphate present in the raw water will be found unchanged in the treated water.

One can generally agree with the other remarks Mr. Bannister makes. Without doubt there are cases where an additional internal treatment or boiler-water conditioning is called for; for instance, in such cases where, through condenser leakage, hard raw water enters the boilers.

K. VON ELTZ, Manager,
Reisert Automatic Water Purifying Company.

New York City.

New and Improved EQUIPMENT

A Chain-Grate Stoker Without Ignition Arch

AS AN efficient mechanical method of burning both anthracite and bituminous coal the traveling-chain-grate stoker has long been recognized. Its application, however, to heating boilers and to low-set power boilers has been limited because of lack of headroom for the installation of ignition arches that have been considered necessary in the operation of this type of stoker.

The Boiler & Stoker Engineering Company, Grand Central Terminal Building, New York City, has developed in the Metropolitan Stoker a chain-grate stoker that will operate without the usual ignition arch. Thus this stoker can be installed under many boilers where an installation of the ordinary chain grate with its ignition arch would not be practicable, and the absence of an ignition arch should materially reduce the amount of furnace maintenance.

The figure shows a cross-section and front view of this stoker installed under an internally fired tubular boiler. A magazine hopper is provided from which coal is fed to an over-feed grate section. Thus the coal introduced on top of burning fuel ignites from the bottom which, it is claimed, produces more rapid ignition than can be obtained with the ignition arch. After ignition the chain grate removes the fuel from this zone and carries it under the leveling pipe, which sets the fuel depth and levels the bed. The leveling pipe may be either air or water cooled, whichever is most convenient. It is made of a special chrome steel alloy which is claimed to be resistant to oxidation and abrasion at high temperatures.

The fuel is gradually burned out during the travel of the grate, and the ash is deposited in a shallow ashpit from which a conveyor picks it up and deposits it in a can or other receptacle or in an ash storage bin.

The stoker is designed to permit up to 200 per cent boiler rating when operating under forced draft. The windbox under the stoker is divided into three chambers, or zones. Air pressure varies from a maximum in the first or ignition zone to medium and low pressure in succeeding zones. Dampers are provided so that the amount of air supplied to each zone can be separately adjusted to meet the requirements of that zone.

An electric motor drives the stoker through a reduction gear and ratchet. The ratchet drive allows the speed of the grate travel to be adjusted to meet the load demands. All drive action is through steel drive chains, one on each side of the stoker, and no driving strain is exerted on the cast-iron grate links, thus tending to obviate link breakage.

The stoker is built in sizes suitable for installation under all types of boilers from 500 sq.ft. of heating surface up. Installations can be applied to steel heating boilers where the maximum distance from floor line to mud ring is only 15 inches.

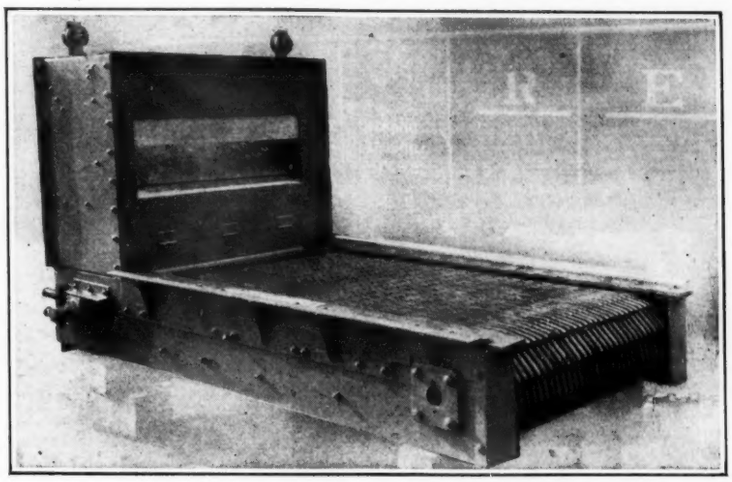


Fig. 2—General view of stoker assembly

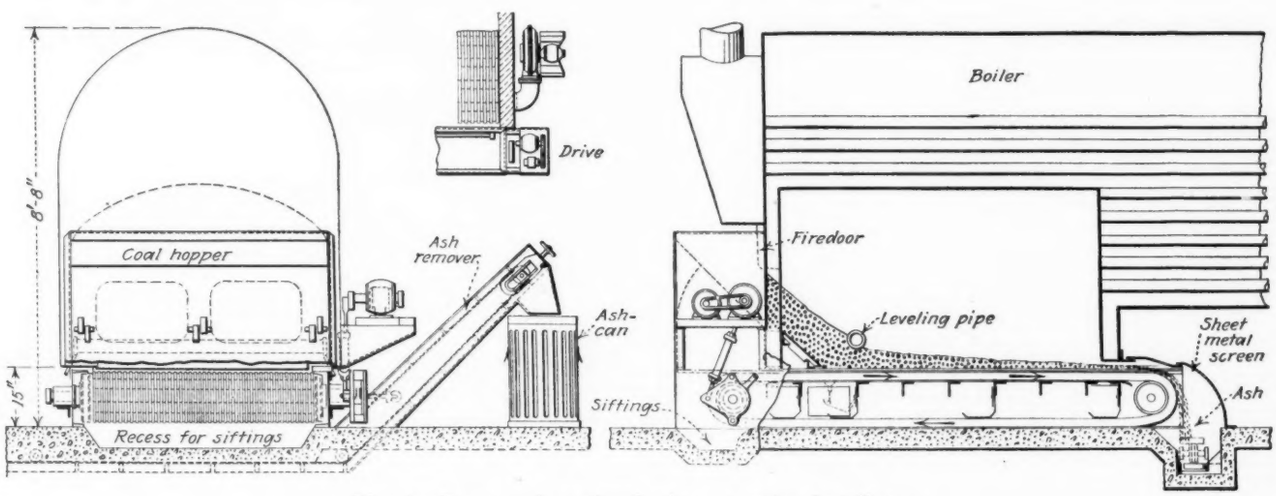
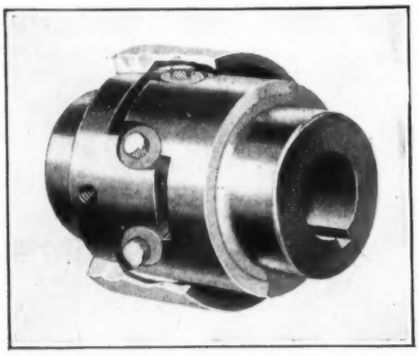


Fig. 1—Front and sectional view of stoker installation

Lovejoy Flexible Coupling

A TYPE of flexible coupling in which the flexible feature is accomplished by means of loosely floating resilient rollers placed between the two jaws of the coupling, is a recent product of the



Coupling with outer cover cut away to show rollers

Lovejoy Tool Works, 391-331 West Ohio Street, Chicago, Ill.

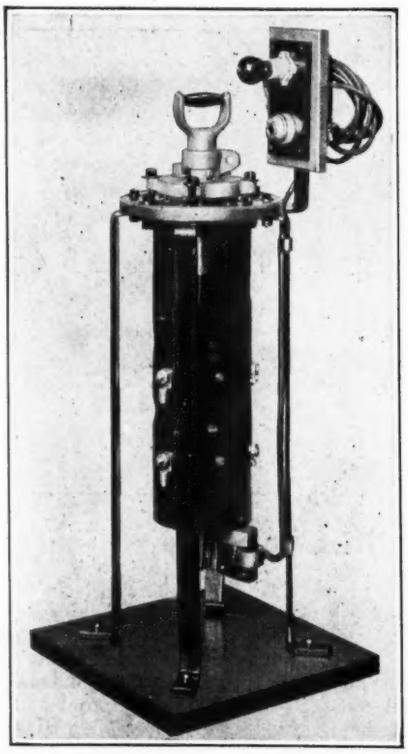
Referring to the illustration, which shows a section of the outer cover cut away, it will be seen that the rollers are placed radially between jaws that extend from flanges parallel with the shafts. This construction gives a rolling contact between the jaws upon relative movement caused by either misalignment or end movement of the shafts. Either solid rubber or rubber-covered metal rollers are used, as conditions require; an external sleeve prevents idle rollers from flying out under centrifugal force. The coupling can be used for rotation in either direction, half the rollers being under compression and the other half idlers. The only wearing parts of the coupling—the rollers—are readily renewed by simply sliding back the outer cover. The coupling is being made in shaft sizes from ¾ to 5 inches.

Short-Circuiting and Grounding Switch

TO MAKE it easy and safe to disconnect, short-circuit and ground high-voltage equipment that is to be worked on, the Packard Electric Company, Warren, Ohio, has developed a combination short-circuiting and grounding switch shown in the figure. This switch has three positions: Connecting the primary cables to the high-voltage windings of the transformer; disconnecting the transformer from the line; short circuiting and grounding the primary windings of the transformer.

On the switch there is an electrical interlock to prevent its operation while the transformer is alive from either the secondary or primary sides. The electrical interlock coil is connected to the low-voltage side of the transformer. If, after the high-voltage side has been disconnected, the low-voltage side is alive from another source, the short-circuiting and grounding switch cannot be opened, until the low-voltage side of the transformer has been disconnected. This prevents any possibility of the transformer being made alive from either side when workmen are at work on it.

The switch is contained in a heavy cellulak tube. Inside this tube are bolted stationary gun-metal contacts for the various connections. An insulated rod carries brush contacts that can be



Switch assembly without the oil tank

rotated to make the different connections. The switch is contained in an oil tank to insulate all parts from the effects of moisture and dirt and high voltage.

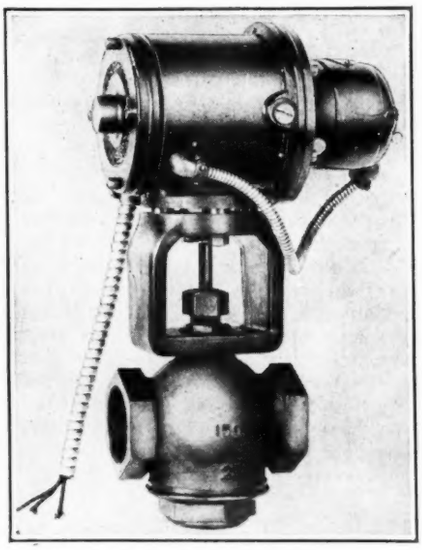
The Bristol Type "B-K" Valve

THE Bristol Company, Bristol, Conn., has recently introduced the electric-motor-operated valve for steam, water and compressed air, illustrated herewith.

A heavy globe-valve body of standard design is employed, and the operating unit is supported on a rigid bracket with provision for keeping the high temperatures away from the motor and operating mechanism. The valve is operated by a cam, acting on a follower directly in the line of the stem and tending to force it to the open position. The speed reduction from the motor to the camshaft is accomplished by a train of cut spur gears. All gearing is contained and totally inclosed within a substantial cylindrical cast metal gear box.

The motor is carried on one end of the gear box by a waterproof mounting. A limit switch whose function is to clear the motor circuit when the operation of opening or closing the valve is completed, is mounted in a readily accessible compartment in the end of the gear box remote from the motor. This switch is actuated by a small cam carried on the main camshaft and is thus positively interlocked with the valve. The switch parts are constructed of heavy phosphor-bronze strip with massive tungsten contacts, and the whole is mounted as a unit within a molded Bakelite casing.

The valve is not of the "floating" type, but comes to rest either tightly closed or wide open. Thus the motor is not required to reverse, but when started, continues to run until the cam has made half a revolution, closing or opening the valve as the case may be. Then the circuit is automatically cleared by the action of the limit switch. While the valve is designed primarily for use with the Bristol temperature controller,



Motor-operated valve for control of steam, air or water

it is adaptable to a variety of wiring arrangements, and complete control may be obtained with a single-pole double-throw switch.

The valve is suitable for installation on steam lines to practically any service where there is required the automatic or remote control of temperature or humidity by means of steam, or in any place where the control of steam, air or water from a remote point is desired. The valve is available in all sizes from ½- to 2½-in. and for pressures from 150 lb. in the smaller sizes to 75 lb. in the larger sizes.

Is There an Unemployment Problem?

Present conditions as analyzed by Magnus W. Alexander from limited data available

AVAILABLE information indicates that employment conditions in the country as a whole have been improving since December, even though public attention was not focussed on the unemployment situation until late in January and in February, according to Magnus W. Alexander, president of the National Industrial Conference Board, speaking before the Fortnightly Forum in New York on March 11.

The extent of unemployment in the United States cannot be measured because of the lack of adequate statistical data, Mr. Alexander pointed out. He characterized the claim that mechanization of industry is responsible for unemployment as a generally unwarranted contention.

As mechanization of industry, with its requirement of fewer workers per unit of production, decreases production costs and prices, the demand for commodities simultaneously increases and not only causes the theoretically released workers to be reabsorbed, but in addition calls new workers into production.

AT ALL times, barring perhaps periods of warfare, there exists an unemployment situation. Even when greatest business activity prevails, some potential workers will be found to be unemployed and many more to be unemployable for one reason or another.

After nearly seven years, or since the depression of 1921 to 1922, unemployment has again found its way onto the front pages of our newspapers and widely diverging guesses and assertions are made as to its extent and consequences. As a matter of fact, there are in this country no comprehensive statistics available which would supply an adequate basis for measurement of unemployment. What indices of employment are published from time to time account only for the number of employees in a given group of establishments in a given branch of national activity. The National Industrial Conference Board, for instance, publishes every month figures showing the fluctuating employment in about two thousand manufacturing establishments employing somewhat over three-quarters of a million people.

Existing Reports Fragmentary

Labor exchanges and employment bureaus are making reports from time to time, but even a marked increase for a certain time in applications for work, the same as in applications for charity to charity organizations, while it would generally suggest increasing unemployment, would hardly give a basis for accurate measurement of the number of unemployed. Then there are the valuable reports of unemployment among trade union members. But inasmuch as all trade union membership in the United States represents only about 10 per cent of all gainfully occupied, these data can hardly be called representative.

There have been definite indications of a decline in employment in 1927, but there are also similar indications that employment since December, 1927, has again slightly increased, and the increase has continued until the present time. The presumption is that with the coming of the warmer season resumption of building construction, agricultural and other open-air activities will absorb many of the now unemployed persons in the United States.

There has, however, in later years come a new aspect into the unemployment situation that seems not to be fully understood and, therefore, is leading to confusion of thought. That is the superficial interpretation of the effects of mechanization of industry. This substitution of power-driven machinery for manual labor, it is claimed, is throwing people out of work; and a magazine writer recently stated that "the price of industrial progress is unemployment." If this conception were true, we might as well renounce our entire system of present-day civilization and return to the more primitive conditions of living.

Let us concretely analyze the situation as the National Industrial Conference Board has found it, by a study of the latest available comprehensive data, as revealed in the United States Census of Manufactures for 1925. At that time 71 wage earners instead of 100, and 82 managerial and supervisory persons instead of 100, produced the same volume of production as was obtained in 1914. The cost of management in 1925 was actually 10 per cent less, and the cost of labor, in spite of wage levels about twice as high as those prevailing before the war, was actually reduced by about 4 per cent per unit of production in contrast with the cost in 1914. Nor was this productivity of the wage earners achieved by longer hours or harder work, for the number of hours in 1925 per worker employed was about 9 per cent less than in 1914, and yet the productivity per wage earner was actually 40 per cent greater. A study of several hundred corporation returns indicates that this general picture holds good also for 1927, even to an increasing degree. This almost paradoxical condition is explainable largely on the ground of a more than 30 per cent increase in mechanical power in the productive process, of improved machinery, tools and production methods, of better organization in the utilization of human factors and their better co-ordination with all other production factors.

If the productivity of industry through mechanization should continue to increase at the same rate for the next 25 years as for the first 25 years of our century, and it may do so at even a much faster pace, it would in 1950 require but 45 workers to produce what now requires a force of about 70 and what in 1914 required a force of about 100 workers. The figures cited are averages for all industries. In some industries the advance has been greater; in some others it has been smaller.

Released Workers in New Fields

The very pertinent question, however, arises as to what has become of the 29 per cent of workers in manufacturing without whom the same amount of production is now being carried on as compared with 1914. The answer is that although, as stated before, productive output per wage earner between 1914 and 1925 had increased by 40 per cent, the total manufacturing production in the same period increased over 65 per cent and necessitated an increase in the required labor force of about 1,500,000 wage earners. In other words, while 71 men in 1925 did produce as much as 100 men in 1914, the demand for manufactured goods at their lower production cost and selling price expanded sufficiently to reabsorb not only the 29 per cent of workers theoretically released, but in addition called 1,500,000 more workers into action. The result was that the value of manufacturing

production in 1925 amounted to nearly $63,000,000,000, as against only $24,000,000,000, in 1914, but manufacturing used nearly 36,000,000 hp. for its processes as against only 22,250,000 hp. in 1914.

These observations refer only to manufacturing industries. A similar contraction of the number of workers employed has, however, been found to have occurred in transportation, construction, mining and agriculture.

It is a well demonstrated economic principle that increased production creates new wants, and that new industries bring with them new demands for both goods and services.

Increased mechanization of industry, with its mass production at lower cost, has had another vital effect upon the economic status of the wage earner and is of great significance in relation to temporary unemployment. Under these new conditions of production industry has been able to maintain the very high wage levels which the circumstance of the World War helped to establish, even though the cost of living has declined considerably from the peak of the post-war inflation period. At the present time wages in manufacturing are considerably more than double those of 1914, while the cost of living is only about 63 per cent above the 1914 level. The net result is that the purchasing power of the wage is now about one-third greater than prior to the beginning of the war.

On the whole, without attempting to estimate the total number of unemployed at present, I believe that there is a temporary condition of unemployment in excess of the so-called normal. I do not consider it, however, as acute or as critical. The weather man may be blamed in part. Also, certain extraordinary conditions, like the strike in the bituminous coal fields, are contributing to the amount of unemployment, although the solution of this particular problem transcends the field of unemployment relief. To be sure, the textile industry of the New England States has for some time been unable to give more than about two-thirds the amount of employment that it gave during its more prosperous times, but on the other hand, the Southern textile industry has been correspondingly increasing employment by nearly one-third over that which prevailed in the peak years of business activity right after the termination of the World War in 1919 to 1921.

It is now the task of industrial management so to increase the stability of production that employment fluctuations may be reduced to a minimum. Public authorities and private management should alike be watchful that no undue employment situation develops and should be ready to counteract by proper means the hardships of material unemployment that may exist in any particular locality. True signs, however, are lacking that there is a marked increase of forced idleness in the United States involving growing poverty.

An Investigation of Engineering Education*

By R. L. Sackett†

A RECENT survey of curricula students and graduates of engineering colleges in the United States and Canada, made by the Society for the Promotion of Engineering Education, has resulted in the collection of some interesting data.

In that study 32 institutions took part and reported on 4,000 freshmen. It developed that about 18 per cent of the freshmen were honor students in their high-school classes; over 42 per cent of the remainder were in the upper third of their class; 37 per cent in the middle third, and less than 3 per cent among the lower third. It was shown that engineering students, as a rule, maintain relatively high scholarships in drawing, manual training, mathematics and physics, but are lower in chemistry and still lower in history and below the average in English and modern languages. The majority of freshmen in entering engineering classes form their decision to do so before graduating from high school; in fact, more than half had decided before entering the last year.

The reasons given for going to college and selecting engineering in the order of their importance, as indicated by the number of answers, were: The definite appeal of engineering; expectation of gaining a good living; advice of parents, teachers or friends; preparation for life work, and various works or associations. One of the most important conclusions drawn from the survey of freshmen was that they had selected the field of engineering without having a knowledge of the nature of the work of the engineer and the requirements for success in this field. This is such a vital matter that attention was immediately turned to possible ways of assisting high-school students and their teachers to obtain a more complete conception of engineering at a time when it would be most useful.

A study of the reason for students leaving college before completion of their education disclosed that 38 per cent of those entering graduated, and of the remainder 22 per cent voluntarily withdrew for family reasons, on account of health or financial difficulties, or transferred to other courses. Failure in scholarship accounted for about one-third of the total number of entering students.

A charge has been made that the engineer, following graduation, enters into a variety of other fields quite different from those for which he was prepared. Data on this subject were gathered from 4,000 recent graduates of 43 institutions and from over 2,000 who graduated during the years 1884 to 1919. There was reasonable agreement in the data obtained from the two groups, and it showed that, on the average, about 65 per cent of those graduating from a given engineering course, continued in that field or a closely related field of engineering.

Many of the graduates indicated that they felt the need for more economics, history, sociology, philosophy, literature and fine arts, and urged that various subjects be included in the curricula. However, numerous agencies are now available to a student who desires additional instruction in any of these fields, and instead of adding more to the engineering curricula, it seems best for the aggressive student to accept some part of the various educational opportunities available for continued study in the fields of their interests or needs.

Cost of Engineering Education

Forty-five institutions reported a total investment devoted to engineering education amounting to $116,000,000. Of this $62,000,000 was in endowment, $32,000,000 in building, nearly $12,000,000 in equipment and $10,000,000 in land. The investment per student ranged from a minimum of $1,470, to $10,760, and the weighted average was $4,800. The average cost per year of educating an engineering student was given as $610, according to the data received from over 20,000 students. Of this cost the student pays about 28 per cent and the remainder is obtained from endowment and public appropriation.

Technical study in engineering education has, in the past, received an emphasis that was not exaggerated in view of the demand for the development of our material resources. Now, however, opinion indicates that the technical study should make way for greater emphasis upon the economic problems which face the engineer if he is to assume the professional position to which he is entitled. Statistics show that a considerable portion of our engineering graduates are promoted into administrative positions, and, undoubtedly, the human element should also receive more emphasis from technical education than it has in the past.

*Abstract from "Results of the Investigation of Engineering Education," *Penn State Engineer*.

†President, Society for the Promotion of Engineering Education.

Boiler Feed Water Abstracts

ON PAGE 721 of the May 10, 1927, issue appeared the "boiler feed water abstracts" contained in the fourth report issued by Subcommittee No. 9 (bibliography) of the "Joint Research Committee on Boiler Feed Water Studies." The work is carried on under the auspices of the American Society for Testing Materials, the American Water Works Association, the National Electric Light Association, the American Railway Engineering Association and the American Society of Mechanical Engineers, with Sheppard T. Powell as chairman of the Advisory and Editing Committee.

The following abstracts contained in the fifth report of Subcommittee No. 9, of which Prof. George Stetson is chairman, consist of items selected by the regular editorial staff of the *Engineering Index* and issued through the courtesy of the A.S.M.E. main research committee.

Boiler Feed Water

Analysis—Notes on Water Analysis, D. Burton and J. K. Haslam. *Chem. & Industry*, Vol. 46, No. 12, Mar. 25, 1927, pp. 111T-114T. Draws attention to several points in analysis of boiler feed waters, which is of interest to all industries.

Apparatus—Feed Water and Feed-Water Apparatus. *Log*, Vol. 9, No. 2, May, 1927, pp. 20-28. Care and test of water and operation, care and repair of equipment, as advocated by manual of engineering instructions.

Foaming and Priming—Some Observations on Priming and Foaming, Cyrus Wm. Rice. *Power*, Vol. 65, No. 15, Apr. 12, 1927, pp. 544-46, 4 figs. Priming and foaming defined; effect of rating on impurities in steam; effect of high water and sharp variations in boiler load; safe concentrations for various types of boilers at various ratings; practical operating rules.

High-Pressure Boilers—Feed Water Treatment for High-Pressure Boilers (Speisewasserversorgung der Hochdruckkessel), V. Rodt. *Zeit. des Bayerischen Revisions-Vereins*, Vol. 31, No. 1, Jan. 15, 1927, pp. 5-6. Points out that large amount of salt that must be removed from feed water for high-pressure boilers cannot be extracted by any chemical purification process; turbine exhaust steam and condensation water are used as feed water, but remaining additional water must be obtained by thermal treatment, that is, precipitation of water from steam; with this process it is necessary to evaporate water economically with exhaust steam, and in condensation of this water heat of condensing steam must be utilized for preheating of feed water; systems of this kind have already been developed by different firms.

Hydrogen-Ion Concentration—Potentiometric Determination of Hydrogen Ion Concentrations in Boiler Waters, W. N. Greer and H. C. Parker. *Am. Water Wks. Assn.*—II, Vol. 17, No. 5, May, 1927, pp. 569-82, 7 figs. Alkalinity measurements as means of approximating H-Ion concentration; determination of hardness by soap method gives, at best, only approximate value; there is more or less definite relation between alkalinity and pH of natural waters at lower alkalinities; use of hydrogen and quinhydrone and tungsten electrodes.

Impurities—Impurities in Feed Water and Their Effect on Boiler Operation, J. B. Romer. *Power*, Vol. 66, No. 1, July 5, 1927, pp. 32-33. Minerals in boiler water; effects of various minerals on boiler operation; corrosion; abstract of paper read before Am. Water Works Association.

Oil Removal—New Process for Removing Oils from Condensation Water for Use as Feed Water and for Making Crystal Ice, Neues Verfahren zur Entölung von Dampfwasser für Kesselspeisung und zur Herstellung von Kristalleis, E. Sandherr. *Wärme- u. Kälte-Technik*, Vol. 29, No. 11, June 1, 1927, pp. 141-43, 2 figs. Description of Dyxhorn process, patented in Holland, for skimming, filtering and chemical treatment of water of condensation to remove oils from it; system of making ice as by product, employing exhaust steam.

Oxygen Recorder—An instrument for Recording Dissolved Oxygen in Feed Water. *Eng. & Boiler House Rev.*, Vol. 40, No. 12, June, 1927, pp. 621-24, 2 figs. Patent recorder is robust boiler-house instrument, that records percentage of oxygen on chart calibrated in cubic centimeters per liter of water and thus enables defects in feed water system to be instantly detected.

Purification—The Purification of Water for Boiler Feed Purposes, T. R. Duggan. *Eng. Inst. Canada—Jl.*, Vol. 10, No. 8, Aug., 1927, pp. 379-85, 6 figs. Review of the various methods of water purification. Paper read before Montreal Branch of The Engineering Inst. of Canada, March 10, 1927.

Salinity Recorder—Crockatt's Electric Salinometers. *Machy. Market*, No. 1376, Mar. 18, 1927, p. 23, 3 figs. Patented instrument which continuously and automatically records degree of salinity of feed water; all that is necessary is to connect feed water supply to electrode cell and lead from lighting mains to electrical circuit.

Testing—Lime-Soda Diagram as Aid in Feed Water Treatment (K-S-Wasserdiagramm als Hilfsmittel bei der Wasserpflege), I. W. Arbatsky. *Wärme*, Vol. 50, Nos. 19 and 20, May 13 and 20, 1927, pp. 329-53, 10 figs. Criticizes present-day criterion based on hardness of water, saying it leads to wrong results and gives no suggestion as to method of purification; presents new criterion based on lime-soda relationship, also diagrams for solving problem of this kind and describes special apparatus designed for testing waters on basis of new criterion.

Treatment — Factors Bearing on Proper Water Treatment, D. C. Carmichael. *Power Plant Eng.*, Vol. 31, No. 9, May 1, 1927, pp. 505-09, 7 figs. Analysis of data collected in three plants to determine most important factors to be considered in treatment of feed water.

Treatment—Feed Water for World's Largest Boilers Receives Zeolite and Acid Treatment. *Power*, Vol. 66, No. 3, July 19, 1927, pp. 90-94, 5 figs. To prevent scale formation in boilers operating at 300 per cent rating when fed with 90 per cent makeup, Zeolite softening was selected and followed by treatment of sulphuric acid, to reduce high caustic alkalinity in zeolite water.

Treatment — Feed-Water Treatment. *Elec. West*, Vol. 58, No. 6, May 15, 1927, pp. 389-92. Methods employed by Southern Pacific Co.; Mare Island Navy Yard; Great Western Power Co.; Pacific Gas & Electric Co.; Southern California Edison Co. Long Beach Steam Plant; Los Angeles Gas & Electric Corp.; San Joaquin Light & Power Corp. Prime Movers Committee Report to Pacific Coast Elec. Engrs.

Treatment—Preliminary Purification of Boiler Feed Water (L' épuration préalable de l'eau d'alimentation des générateurs), M. J. Guth. *Assns. Francaises de Propriétaires d'Appareils á Vapeur*—Bul., No. 28, Apr., 1927, pp. 136-46, 5 figs. Discusses elimination of scale-forming salts and other harmful elements from feed water before it enters boiler; physical, chemical and combined physicochemical process.

Treatment — Some Notes on Feed Water Treatment, A. Seton. *Eng. & Boiler House Rev.*, Vol. 40, No. 11, May, 1927, pp. 569-70. Most of failures that are recorded are directly due to water and its dissolved constituents, including gases and oil in suspension; the ideal plan, which is not always practicable, is to condense all steam after use and to use condensates as makeup; under best conditions 90 per cent of steam generated may be recovered in this way; softening of boiler water.

Treatment—Treating of Water for Boiler Feed Pays Handsome Dividends. F. B. Good. *Nat. Petroleum News*, Vol. 19, No. 21, May 25, 1927, pp. 59-62.

Deals with different systems of treatment.

Zeolite Treatment — Zeolite Water Treatment in a Large Central Heating Plant. A. H. White, J. H. Walker, E. P. Partridge and L. F. Collins. *Am. Water Works Assn.*—Jl., Vol. 18, No. 2, Aug., 1927, pp. 219-44 and (discussion) 244-49, 9 figs. Zeolite water treatment system in the Beacon Street heating plant of the Detroit Edison Co.; results of some extensive preliminary laboratory investigations carried on at University of Michigan to determine possibilities of removal of carbon dioxide from zeolite-treated water by means of sulphuric and phosphoric acid; actual operating results are also included.

Complete De-Oiling—Anon. Apparatebau *39*, 161-2 (1927). *Chem. Abstracts*, Sept. 10, 1927, *21*, 2948. A little freshly pptd. $Al(OH)_3$ added in the last section of the sepg. tank before the filter removes all of the oil.—J. H. Moore.

Degassing — Ges, P. Müller, Brit. 254,707, July 3, 1925. *Chem. Abstracts*, Aug. 20, 1927, *21*, 2752. An ejector for creating a partial vacuum on the feed H_2O is fed with steam generated by reducing the pressure on H_2O from the boiler.

Distilling With Exhaust Steam—Meyer, A. Brit. 256,199, July 31, 1925. *Chem. Abstracts*, Sept. 10, 1927, *21*, 2949.

Factors Bearing on Proper Treatment—Carmichael, D. C. *Power Plant Engineering 31*, 752 (1927); cf. C.A. *21*, 2344. *Chem. Abstracts*, Aug. 10, 1927, *21*, 2518. The determination of the quantity of oil in steam is carried out by extracting the oil from the condensed steam with ether, evaporating the ether extraction in a tarred vessel to constant weight at 90 deg., and weighing. When suspended matter is present, $FeCl_3$ and NH_4OH are used to precipitate the suspended matter and oil. After suspended matter and oil are filtered, the filter is dried at 90 deg.; the oil is extracted from the ppt. with ether and a Soxhlet apparatus. From this point the determination is carried out as above.

Boilers

Corrosion—Boiler Corrosion and Pitting. *Boiler Maker*, Vol. 27, No. 5, May, 1927, pp. 138-39. In its search for information as to progress in combating evils of pitting and corrosion, committee sent out questionnaire to which 39 replies were received. Abstract of report presented to Master Boiler Makers' Assn.

Deterioration — Cause of Dangerous Boiler Deterioration, C. E. Stromeyer. *Power*, Vol. 65, No. 17, Apr. 26, 1927, pp. 648-49. Prominence is given to uniform wasting, which is most misleading and dangerous corrosion to be met with in boilers, and has been the cause of many disastrous explosions; incrustation; causes of failures of apparently sound plates, prominence being given to possibility of caustic embrittlement. Abstract of 1926 report of Manchester Steam Users' Assn. of London.

Failures—Boiler Failures. *Engineering*, Vol. 123, No. 3199, May 6, 1927, pp. 552-53. Review of memorandum by C. E. Stromeyer in which he gives list of exhibits in his museum and valuable comments upon them; prominence is given to subject of uniform wasting; case of scale falling off two furnaces of Lancashire boiler and forming bed of loose sediment on front end of shell; introduction of caustic soda or carbonate into boilers for anti-corrosion or anti-scale purposes is generally accepted as almost certain cause of failure, owing to embrittling action of these substances.

Scale Removal—Boiler Scale Prevention by an Entirely New Method. *Eng. & Boiler House Rev.*, Vol. 40, No. 12, June, 1927, pp. 628-30. Process, known as "Etherium" scale-treatment method, consists of specially prepared compound, which is placed inside sealed metal canisters, and these canisters are placed in feed water tank; peculiarity of this special compound is that although not in contact with water, it changes the nature of solid content of water, both those in suspension and in solution, such change having the effect of preventing solids from forming scale inside boiler.

Preventing and Removing Scale—Schenitza, P. U. S. 1,617,350, Feb. 15, *Chem. Abstracts 21*, 1161, April 10, 1927. A compound for preventing and removing scale is formed from a rosin such as colophony mixed with a protective colloid; for example, gum arabic and with borax, waterglass and ultramarines.

Preventing Scale Formation—McDermott, T. Brit. 251,122, May 29, 1925. *Chem. Abstracts*, April 20, 1927, *21*, 1321. Soda crystals are added to the feed water to render it alkaline and a perforated wood receptacle containing compressed swede turnip root with or without the addition of cabbage and heather chopped fine is suspended in the boiler.

Corrosion

Differential Aëration — Differential Aëration Corrosion Theory, W. B. Lewis, and *Eng. & Boiler House Rev.*, Vol. 40, No. 11, May, 1927, pp. 583-84. G. S. Irving. Water-level corrosion; factors which influence corrosion; calcium nitrate, calcium chloride, magnesium chloride, magnesium nitrate, carbonic-acid gas and oxygen, are chief corrosive substances in boiler feed waters, and it is their influence and effect which have to be neutralized if corrosion is to be prevented.

Metals — Corrosion (Reichsausschuss für Metallschutz). *Zeit. für angewandte Chemie*, Vol. 40, No. 3, Jan. 20, 1927, pp. 96-103. Symposium of papers at 1926 meeting of Reichsausschuss für Metallschutz, as follows: Corrosion Research in England, M. Haas; Rust Damage and Protection Costs, W. Widderholt; Stainless Steels, Strauss; Estimating Rate of Rusting and Rusting Tendency, Especially of CR Steels, Dufek; Aluminum Corrosion, E. Maas; Nomenclature of Tars and Bitumens; Mallisson; Waters Which Attack Metals and Cement, Klut; Corrosion and Practical Boiler Operation, A. Splittgerber; Colloid Chemistry and Corrosion Research, Beck; Theory of Surface Coatings, A. Blom; Storch-Morawski Reaction, H. Wolff; Corrosion Protection by Coatings, O. Jäger; Standardization, K. Wuerth; Chemical Behavior and Overvoltage of Metals, F. Liebreich; Cable Corrosion, O. Haehnel; Light Aircraft Alloy Corrosion, Rackwitz.

Pipe Lines—Prevention of Corrosion in Steel Pipe Line, W. K. Weller. *Water Works*, Vol. 66, No. 7, Aug., 1927, pp. 342-43, 1 fig. How deaëration process is used on 350-mile line in Western Australia described in paper presented Feb. 27 at annual conference of Institution of Engineers, Australia.

Steel Pipe—Failures—Peculiar Failure of Steel Water Pipe, J. W. Hall. *Water Works*, Vol. 46, No. 7, July, 1927, p. 265. General conditions, the cause of failure and remedy.

Boiler—A Problem in Boiler Corrosion, Denham, H. G. *Trans. Proc. New Zealand Inst. 57*, 900-1 (1927). *Chem. Abstracts*, Aug. 10, 1927, *21*, 2518. The excessive corrosion of boiler tubes was found to be due to the presence of 2.52 grains per Imp. gallon of silica in the feed water. It was further enhanced by high concentrations of Ca and Mg salts. From the analytical data given, a formula for treating the feed water was developed. A mixture of $2\frac{1}{2}$ lb. of soda ash and $1\frac{1}{2}$ lb. NaOH per 10,000 gallons of feed entirely eliminated the corrosion.

Impure Water Factor in Corrosion—Peters, Otto. *Oil and Gas J. 25*, No. 45, 168 (1927). *Chem. Abstracts*, Aug. 20, 1927, *21*, 2751. Boiler water is treated with a solution made by diluting 120 lb. lime with 150 lb. soda ash and adding 15 lb. alum in 4 bbl. mixture which is fed into the chemical tank at a rate taking 24 hours.

Condensers—Tubes — Some Investigations into the Cause of Erosion of the Tubes of Surface Condensers, C. A. Parsons. *Shipbldg. & Shipg. Rec.*, Vol. 29, No. 15, Apr. 14, 1927, pp. 412-16, and (discussion) 446-49, 6 figs. Account of experimental investigations designed to throw light upon actual conditions attending regional disturbances in waterbox, and manner in which they effect character of flow through tubes in their vicinity, also to investigate possibility that pitting of condenser tubes may in reality be due to water-hammer of collapsing vortices, which is known to be potent cause of erosion of screw propellers and of impellers of centrifugal pumps and water turbines. Abstract of paper read at Instn. Nav. Architects, Apr. 6, See also *Engineer*, Vol. 143, No. 3717, Apr. 8, 1927, pp. 390-91, 8 figs.

Water Softening

Advantages—Water Softening as an Adjunct to Water Purification. C. P.

Hoover, *Am. Water Wks. Assn.—Jl.*, Vol. 17, No. 6, June, 1927, pp. 751-59. Reason why so few softening plants were built; recarbonization and other developments; use of coagulants in softening; zeolite process; operation of lime-zeolite softening plant; differences between water filtration and water softening; advantages of softening.

Chemistry—Chemistry of Water Softening Simply Explained. *Eng. & Boiler House Rev.*, Vol. 40, No. 12, June, 1927, pp. 616-18. Attempt is made to give essential facts relating to main chemical reactions involved in purification of boiler feed water, especially as regards elimination of scale.

Cold-Process Softener—The Porter Water Softener, J. Mills & Co., *Mech. World*, Vol. 81, No. 2112, June 24, 1927, pp. 449-50, 3 figs. Cold-process softener supplying 2,500 gal. per hour of boiler feed water for Radcliffe mill; sufficient lime and soda ash to last from 8 to 12 hours is dissolved in lime mixer.

Lime—Use of Lime in Water Softening and Water Purification, C. P. Hoover, *Pit & Quarry*, Vol. 14, No. 5. June 8, 1927, pp. 59-63. Addition of lime to water not only softens it but when added in sufficient quantity to produce residual or excess lime, caustic alkalinity, kills intestinal and pathagenic bacteria, rendering water safe bacterially.

Well Water—Water Softening Plant of Miami, Fla., L. R. Howson. *Water Works*, Vol. 46, No. 7, July, 1927, pp. 267-70, 4 figs. Largest plant in country for softening well-water supply; paper presented at Am. Water Works Assn.

Zeolite—Recent Developments in Zeolite Softening, A. S. Behrman. *Indus. & Eng. Chem.*, Vol. 19, No. 4, Apr., 1927, pp. 445-47, 3 figs. Demand upon modern zeolite water softener are considerably more exacting than those made on its predecessors; chief among these are greater softening capacity per given volume of zeolite, more rapid rate of base exchange, and minimum loss of water pressure through zeolite bed; distinct advance has been made possible by development of synthetic "gel" type of zeolite, which is principal subject discussed.

Apparatus

Deaërating Boiler Feed Water—Jones R. C. U. S. 1,622,283, March 29. *Chem. Abstracts*, May 20, 1927, *21*, 1687.

Distilling Boiler Feed Water—Akt.-Ges. Brown, Boveri, et Cie. Brit. 255,-050, July 9, 1925. *Chem. Abstracts*, Aug. 20, 1927, *21*, 2752.

Removal of Gas from Boiler Feed Water—Töller, W. Z. angew. *Chem. 40*. 260-2 (1927). *Chem. Abstracts*, June 20, 1927, *21*, 2040. In the absence of other substances like $MgCl_2$ which cause corrosion, O and CO_2 are considered the causes. CO_2 gives H and Fe is dissolved. O serves to depolarize, changing Fe_{II} to Fe_{III}. Addition of alkali is helpful. Removal of O by chemicals is helpful, but expensive. The gases may be removed by mechanical and chemical means. Mechanical means even with heat is difficult. Chemical means using Fe filings or turnings in a filter is the best method for gas removal. Na_2SO_3 might be used, but the sulphate formed increases the concentration of soluble salts in the boiler.

The Scientific Treatment of Boiler Feed Water, Introducing the Colloidal Aspects—Lewis, W. B. and Irving, G. S. *Trans. Ceram. Soc.* (England) *25*, 200-5 (1926) *Chem. Abstracts*, June 10, 1927, *21*, 1860. A general discussion of corrosion and incrustation difficulties in boiler waters.

Thermal Preparation of Boiler Feed Water—Blaum, R. Z. *Ver. deut. Ing. 71*, 285-90 (1927). *Chem. Abstracts*, June 10, 1927, *21*, 1860. Feed water for boilers is deaërated by means of a vacuum evaporator. On shipboard all exhaust steam is used for preheating, evaporating more water to make up loss, and is finally condensed and used for feed water. On shore installations similar use is made, but here the apparatus need not be as compact. Several types made by the Barart Atlas Works are illustrated by schematic diagrams and are said to be quite efficient. These consist of multi-stage evaporators and preheaters. In ground waters, as the gases are driven off, normal carbonates precipitate. The apparatus is fitted with a filter to remove this precipitate.

Water-Cooled vs. Refractory Furnaces*

THE dollar aspect of the water-cooled furnace becomes acute when the smaller sizes of boilers and ordinary load factors are considered. The 5,000-sq.ft. boiler and the 30 per cent annual load factor are still common in both central stations and industrial plants. So long as extra water-cooled surface over and above that inherent in the boiler design costs ten or twenty times as much as the corresponding radiant surface in the boiler, I do not see how one can regard the solution as having been reached for this more general case.

The cost of the various special types of water cooling has perhaps been chiefly sanctioned by the widespread belief that boiler tubing would not stand up under the "punishment" received in the furnace. There doubtless have been cases where this is true. There are also other cases where satisfactory results have been obtained, particularly where heavy-gage tubes have been used. The limit on the weight of the tube used for water cooling should not be the steam pressure. Other considerations may dictate the use of a tube two, four, or even eight gages heavier than the pressure standard. The extra cost is comparatively small. It is not inconceivable either that better heat resisting materials could be used for making boiler tubes.

A case in point is the water-cooled bottom in the furnace of an old bent-tube boiler of 6,110 sq.ft. of heating surface[1]. It is a unit system fired by two burners, the furnace being diamond shaped. When we worked out the essential features of this design about three years ago, it was freely predicted the result would be a failure. When the design was detailed about two years ago, 50 per cent of the companies asked to quote on furnishing the material for the water-bottom said it was doubtful if it would work. However, the bottom has been in use a year and a half under an average heat density of 16,000 B.t.u. per cubic foot of total furnace volume. For several months it operated with the flames impinging directly on it and running up along it into the bottom of the front bank of tubes. It was a really severe case of flame impingement. The result was a few small bags but no tube failures.

After we had developed a burner suitable for this kind of furnace, the bagged places in the tubes were pounded back into place with a welding torch and a hammer. No further trouble has occurred, although the boiler averages 200 per cent of rating on a well water which runs 25 grains of hardness per gallon before being treated. The flames do not impinge on the bottom any more, but it has been demonstrated that the bottom will stand a lot of impingement in emergencies. The diamond shape of the furnace, which represented the adaptation of an old Murphy stoker setting to pulverized coal, provides a "V" for ash collection. Most of the ashes collect in the "V" without assistance, sliding down the firebrick surface which lies just beneath the tubes covering the bottom. The brick are so close to the tubes that they retain their smoothness—even with flame impingement—as a runway for the ash particles. The remainder of the ashes are driven down by a soot blower which is in the usual position and merely has its arc of action increased. Ashes are easily and comfortably removed once each day to the ash car with a six-foot hoe.

The water-bottom installed complete with 3½-in. No. 7 gage tubes (four gages heavier than standard) on 6-in. centers cost $8.30 per sq.ft. of furnace bottom, 14½x15 ft. This is about $38 per horsepower of water-bottom, or per ten square feet of tube surface within the furnace. Even this figure is high because the job was small.

*Excerpt from a written discussion by Guy B. Randall of the paper, "Some Factors on Furnace Design for High Capacity," at the recent A.S.M.E. annual meeting in New York.

[1]Installed at the plant of the National Cash Register Co., Dayton, Ohio.

NEWS *of the* FIELD

Military Affairs Committee To Push Bill Creating Government Corporation to Operate Muscle Shoals

Move Follows Rejection of Norris and Other Bills—Madden Bill Thought Mere Gesture Toward Fertilization Production, but with Real Intent of Securing Power

AFTER voting down the Norris Muscle Shoals bill, the Madden bill and the Morin bill, the House Committee on Military Affairs has plunged into an effort to bring out a bill of its own.

This bill is expected to provide for the creation of a $100,000,000 government corporation to operate the property, make fertilizer and to sell the surplus power. This is a radical departure from the Senate plan and is not likely to meet the approval of that body.

The House Committee regarded the Norris bill as a hodgepodge measure, interlocking the responsibilities of two executive departments in an impractical fashion and dragging in a third secretary in the rate regulation by the Federal Power Commission. There also was objection to the additional installation.

It is also felt that the depreciation would more than offset the limited use that could be made of the additional equipment. The fact that this machinery would use only secondary power would render it of small value, unless the plant were a part of a large system.

The Madden bill was even less acceptable. Some members of the committee feel that it is a gesture toward fertilizer production with the real intent of securing the power. The fertilizer guarantee was not satisfactory. The fact that the bidder for the property was not willing to turn it back if the fertilizer production should not succeed, is cited as evidence strengthening the committee's impression.

The refusal of the bidder to increase the offer when it was established that the Cove Creek Dam and Dam No. 3 would cost more than had been estimated, also had a bearing on the adverse vote.

Another suggestion that has been put forward is that the President be empowered to lease the plant. Should he fail to receive offers satisfactory to him, he is to be empowered to operate the plant until such time as a satisfactory offer may be forthcoming.

Electrical Driven Pumping to Equip Oil Pipe Line

Among recent indications of change from the use of internal-combustion engines to motors for driving pumps on oil pump lines is the announcement that in a few months the Shell Pipe Line Company will equip its pipe line that runs from McCamey, Tex., to Cushing, Okla., with fourteen electrically driven pumping stations, equipped by the Westinghouse Electric & Manufacturing Company.

In each station will be placed an incoming line panel and three motor starting panels of the reduced voltage starting type, to match each of the three motors to be installed, one motor serving as a stand-by unit. The motors are squirrel-cage induction type, with a rating of 400 hp. 2,200-volt three-phase 60-cycle 1,750 r.p.m. They will be connected directly to the centrifugal pumps.

By cutting the distance between McCamey and Cushing into fourteen intervals, a high velocity of flow between stations can be maintained, because the oil is pumped forward in a steady stream.

This smoothness of movement or constant stream of flow from the centrifugal pumps has a tendency to lessen the occurrence of blown gaskets and leaks in the line, thereby lowering maintenance. Furthermore, it gives flexibility of operation and ease in installing.

Automatic Controlled Plant at Alouette, B. C., Soon Ready

What is reported to be one of the most unusual hydro-electric power plants on the North American continent will soon be brought into operation in British Columbia. This is the Alouette plant of the British Columbia Electric Railway Company, which will add 12,500 hp. to the power system at a cost of $2,500,000.

It will be unique in that no operator will be needed, the single generator being controlled from the Stave Falls power house 11½ miles away. The new plant is the second largest automatic power installation on the continent, being exceeded in size only by one station in the State of Washington.

Another feature is that water that would ordinarily find its way down the Alouette River to the Fraser is being diverted through a tunnel driven 3,400 ft. under the mountain range, into Stave Lake. In this way the water will be used for power development at the Alouette plant, again at the Stave Falls plant, and later it will be used a third time, when the British Columbia Electric's plant at the first canyon of Stave River is built.

The Alouette plant built at the mouth of the tunnel will utilize the head created by the difference in level of 140 ft. between Alouette and Stave Lakes. The storage capacity of Alouette Lake has been increased by a dam raising the lake level 45 feet.

N. Y. Assembly Passes Bills to Insure Water Power Returns

The New York State Assembly March 19 passed and sent to the Senate, without debate, the Sargent water-power bills which carry provisions designed to insure to the state an adequate financial return for whatever private water-power development takes place on the inland streams.

The first of the Sargent bills provides for the appointment of a commission of three members to be named by the Governor, the Speaker of the Assembly and the President pro tem of the Senate. The commission is authorized to hold hearings to determine what would be a fair return to the state from private power development on the inland streams.

To Report on Fair Rate from Private Developments

The second of the Sargent bills is designed to give protection to the Adirondack resorts chiefly through specifically forbidding the proposed Oxbow reservoir near Tupper Lake, a provision that has been particularly demanded by Saranac Lake and near-by communities.

The commission proposed is required to report to the Legislature on what it believes to be a fair rate of return from the private power development. If the rate is approved by the next Legislature, the way will be opened for the development of approximately one-third of the undeveloped hydro-electric power in the state, it is contended.

North Carolina Active in Water Power Development

North Carolina ranks fourth in developed water power in the United States, figures released by the division of water resources, State Department of Conservation and Development, reveal.

Water power in actual operation Dec. 31, 1927, amounted to 609,822. It was pointed out, however, that the survey does not include the Senteetah plant of the Tallassee Power Company, which opens soon. This plant has a capacity of 66,000 horsepower.

Plants under construction, and expected to be in operation by late spring will add another 295,000 hp. to the total, and bring the entire water-power capacity of the state to approximately 970,822 horsepower.

Pulverized Fuel a Saving of Cargo Space

Six more freight vessels of the United States Shipping Board are to be converted from oil burners to the utilization of pulverized fuel, and tentative plans have been made to begin work on the steamships "West Alset" and "West Apaum."

The work is under the direction of Capt. R. D. Gatewood, director of maintenance and repair of the Shipping Board, and Carl Jefferson, expert in the powdered coal tests.

With the pulverized fuel it is possible to provide space for 50 more tons of cargo, Mr. Jefferson said. The two vessels selected for conversion are now tied up at Norfolk, Va. The first vessel thus equipped, the "Mercer," has just completed her second round-trip voyage to Europe. The fuel economies and other advantages of this form of coal consumption were said to be satisfactory.

Ships Large Transformer in Nitrogen

A new use for nitrogen in connection with transformers has just been inaugurated in the shipment by the Westinghouse Electric & Manufacturing Company of a 25,000-kva., 110,000-volt, three-phase, 60-cycle unit, without oil, across the continent in an atmosphere of nitrogen under pressure.

This transformer was purchased by the Great Western Power Company and was shipped from Sharon, Pa., to Oakland, Calif., where it is now installed in the Oakland substation of the company.

Before the transformer was shipped it was thoroughly dried and tested. The cover was bolted in place and dry nitrogen was blown through the tank, until the oxygen content of the gas in the tank was reduced to 1 per cent. Additional nitrogen was then introduced until the pressure inside the case amounted to 2.95 lb. per sq.in. at 15 deg. C. By the use of this initial pressure in the tank it was expected that the transformer could be shipped without the danger of air and moisture leaking into the tank, any slight leaks occurring being in the opposite direction because of the pressure. As an additional precaution a bag of calcium chloride was placed in the tank with the idea of taking up moisture if any unexpected leak did occur, and also to give an indication to the men who opened the transformer at the receiving end as to whether any moisture had entered.

The transformer was shipped from Sharon on Dec. 30 and received in Oakland on Jan. 20. Upon its receipt at Oakland it was transported by truck to the substation and was there given a test to show the condition of the gas in the tank. The pressure in the tank was found to be 1½ lb. at a temperature of 15 deg. C. The oxygen content was 1.8 per cent. The tank was then opened and the calcium chloride was found to be perfectly dry. It was, therefore, decided that the shipment had been successful and the transformer was filled with dry oil and placed in service.

By the use of the nitrogen atmosphere the total shipping weight of the unit was reduced 65,000 lb. below the combined weight of transformer and oil. In this particular case the transformer could not have been handled at the receiving end if the additional weight of oil had been present. Had it been shipped without oil and without the use of the nitrogen, a drying out process at the California end would have been absolutely necessary, involving not only delay in getting the transformer into service, but also much expense.

Testing With a 1,000,000-Volt Arc

What a 1,000,000-volt arc 18 ft. long looks like in the testing laboratory of the General Electric Company's new plant at West Philadelphia. This is required to test the insulators for modern oil circuit breaker equipment, which has a rating up to 2,500,000 kva. at 220,000 volts

H. F. Schmidt, of Westinghouse, Gets Naval Engineers' Medal

Henry F. Schmidt, consulting engineer of the Westinghouse Electric & Manufacturing Company, South Philadelphia Works, was awarded the medal of the American Society of Naval Engineers for the best article submitted during the year 1927.

Mr. Schmidt, besides being awarded a gold medal, was given an honorary life membership in the Society and a cash prize for his excellent and well-illustrated paper, entitled "Some Screw Propellor Experiments, With Particular Reference to Pumps and Blowers."

The presentation of the awards to Mr. Schmidt will be made by Secretary of the Navy Wilbur at the annual dinner of the Society to be held on March 29, at the Willard Hotel, Washington, D. C.

Mr. Schmidt studied marine engineering at Columbia University under the late Professor W. L. Cathcart, Commander U. S. Navy. After leaving college, he worked for some time on the turbine test floor at the works of the General Electric Company. For two years thereafter, he was employed as a supervising engineer. In 1905, he accepted a position as lecturer at Queens University, Kingston, Ontario, continuing in this work until 1906, when he was offered, and accepted, an appointment as instructor of mechanical engineering at the Michigan Agricultural College.

Century of Progress Marked by American Institute Dinner

A century of progress in science, industry and commerce was reviewed at the centenary dinner of the American Institute held in the Waldorf Astoria Hotel, New York City, March 21. The speakers were: Edwin F. Murdock, president of the Institute; Thomas A. Watson, Bell's associate in the invention of the telephone; Dexter S. Kimball, Dean of the College of Engineering, Cornell University; Julius Klein, Director of the Bureau of Foreign and Domestic Commerce; John H. Finley, editor of the New York *Times*. Frederic W. Wile, Washington newspaper correspondent, was toastmaster.

Recalls First Phone Message

The occasion was marked by the publication of a large volume, "A Century of Industrial Progress," edited by Mr. Wile, with a foreword by Herbert Hoover and chapters by thirty industrial leaders, including Julius Klein, Charles Schwab, Dexter S. Kimball, Owen D. Young, Frank B. Jewett, John N. Willys and James G. Harbord. Copies of this book, issued by Doubleday, Doran & Company, were distributed for the first time at the dinner.

Mr. Murdock, the first speaker, outlined the activities of the American Institute since its formation in 1828. During the past century, he said, the Institute has contributed greatly, by exhibitions, encouragement of industrial legislation and in other ways to the development of invention and industry. Encouragement of fundamental research, Mr. Murdock declared, is the great present need. To gain popular support for research, the Institute is now laying plans for educational activities that will concentrate public attention on modern scientific achievements.

The relative newness of many great inventions that have become part of the very fabric of modern industrial civilization was dramatically illustrated by the presence of Thomas A. Watson, the first man to hear electrically carried speech. Doctor Watson, still vigorous, told of his work with Bell on the harmonic telegraph and of the misadjustment which led to the discovery of a method of speech transmission. Speaking into the original transmitter he broadcast Bell's famous sentence of 1875, the first ever transmitted by telephone: "Mr. Watson, come here, I want you."

Predicts More Humane Philosophy

Not all agree, said Dean Kimball in his address, that modern industrial progress has been worth while. Some fear it, but this fear, he declared, is founded mainly on ignorance. Dean Kimball predicted the growth of a new and more humane philosophy based on the practical possibilities for universal well being inherent in a fully developed era of industrial efficiency. Now, for the first time in human history, he said, man may hope to conquer his environment. Already some of the leaders of great industries have sensed a duty beyond mere profit making.

Doctor Klein, introduced as America's foremost expert in the field of foreign and domestic trade, pointed out that the annual manufacturing production of New York State has grown from 40 million dollars a century ago to 9,000 million today. In this phenomenal development, he said, the Institute has played an important part by the promotion of agriculture, commerce, manufactures and the arts.

American Engineers Guests at World Congress Dinner

Engineering leaders from practically every part of the United States meeting in Washington the evening of March 22, formulated preliminary plans for the participation of American Engineers in the World Engineering Congress which will be held next year in Tokio.

An American committee to arrange for the part the engineers of the United States will play in the Congress was formally organized and officers elected.

At a dinner given in honor of the American Committee by the Japanese Ambassador at the Carlton Hotel, where the organization took place, Dr. Elmer A. Sperry, of Brooklyn, who was elected chairman of the American Committee, predicted that collaboration of engineers throughout the world will facilitate transactions and intercourse between different countries and greatly contribute to the general development of world industry.

Doctor Sperry pointed out that human welfare is largely dependent upon the activity of engineers and scientists. The coming together of engineers and scientists with the consequent comparing of data and experiences, he said, will not only advance the world's engineering status and contribute to world prosperity, but will simplify production and minimize variations, particularly if international engineering standards were established.

The Japanese Ambassador, Tsunco Matsudaira, said that both Japan and the Engineering Society of Japan under whose auspices the Congress in Tokyo will be held, were gratified at the acceptance of the American engineers to participate in the Congress and at the interest being shown by engineers in the United States.

What Engineering Has Given Japan

In his address the Japanese Ambassador said in part:

"In the progress Japan has made in the science and practice of engineering, she owes a great deal to the assistance and co-operation rendered her by Western Powers. The contribution made by America to her development in this field has been no small one. As far back as 1862 Prof. Raphael Pympelly, of Harvard, went to Japan as adviser to our government in mining and engineering. I am told that it was he who first taught Japanese miners the use of explosives for breaking rocks. In 1873 another American mining engineer, V. S. Lyman, went to Japan, on the recommendation of your government, to make a geological survey of our northern Island, Hokkaido, and to investigate oil wells in Echigo, the coal field in Kyushu and the iron deposits at Kamaishi. His assistant, Mr. Monroe, explored Hokkaido for placer gold and other minerals. He was later appointed professor of geology in the Tokyo University. Furthermore, in recent years our engineers in various branches have come to your country and either as students in technical institutions or as visiting observers of your great engineering enterprises have carried back information which has been of great benefit to us.

"The coming Congress proposes to discuss various questions relating to engineering science, in anticipation of eventually initiating and promoting international co-operation in the study of the science of engineering and its problems in all its branches."

Maine May Have Water Power Probe All Her Own

Appointment of a special commission, headed by Charles E. Hughes, of New York, to study the Maine water-power problem, is urged by Allison P. Howes, state lecturer of the Maine State Grange.

Mr. Howes proposed a commission of three to be chosen by the Governor, by the water-power interests at Augusta and by the Chief Justice of Maine, to look into the facts of the problem and lay them before Mr. Hughes.

He said the differences in rates in communities, the reports of "watered stock" and of other phases of water-power generation and transmission, should be studied.

"Business Offers Engineers Big Opportunities Today," Says W. H. Hovey

Opportunities for the engineer in business are greater today than ever before, according to W. S. Hovey, president of Fairbanks, Morse & Company, who spoke recently on "The Engineer's Part in Business," before the Chicago Section of American Society of Mechanical Engineers. In order to take advantage of these opportunities, however, Mr. Hovey pointed out that the engineer of today must be commercially minded.

Needs of Customers the Key

"While this is true in all lines of business endeavor it is particularly true," said Mr. Hovey, "in connection with the manufacture, distribution and use of specialized products for industry. The trend today in manufacturing and selling is based entirely on the needs of the customer. It is, therefore, more important to supply what the customer needs than what the manufacturer has to sell. It is here that the modern engineer takes his places in both production and sales.

Yesterday's Waste Today's Profit

"Modern business is not only depending more and more on the engineer to analyze the requirements of the customer, but is also calling on him to help increase the profits in business. Competition is so keen that the waste and loss of a few years ago is the profit of today. The engineer, through a careful study of production methods and the elimination of waste, has been able to reduce the amount of material entering into products without in any way decreasing the quality or the factor of safety."

Based on Service to Customer

To produce results that would be beneficial to business, Mr. Hovey suggested that the engineer must have the ability to co-operate. He must be willing to work with men and to take suggestions whether these suggestions come from the workman in the shop or from an official in the organization. The struggle for improvements in design, in production and in the use of equipment is greater than ever before. And behind all this constant struggle, said Mr. Hovey, is the motive of service to the customer, and in so serving to bring a reasonable compensation to the stockholders from the investment in the business.

If the engineer constantly develops a commercially minded viewpoint, he has a greater opportunity to take an important place in business. The training and experience the engineer has had of dealing with facts, of being required to think clearly and base his conclusion upon facts, was pointed out by Mr. Hovey as fitting him, perhaps better than any other profession, for such important positions in the business world.

Equipment for Largest Power Station in Britain

A contract for nine turbo-alternator sets, with an aggregate output capacity of 93,000 kw. to form the equipment of a new power station for the extensive chemical works now under construction for Synthetic Ammonia & Nitrates, Ltd., Billingham, was recently awarded after sharp international competition by Imperial Chemical Industries, Ltd., the large British chemical combine, to the Metropolitan-Vickers Company, Ltd.

In the new installation the double use of steam, first to obtain electric power from turbine-generators, and afterward for process work, will be applied on an unusually large scale. The whole of the plant has been designed on lines laid down by H. A. Humphrey, the consulting engineer to Imperial Chemical Industries.

It will be erected under the supervision of T. M. Wilson, chief engineer of Synthetic Ammonia & Nitrates, Ltd., and of D. M. Buist, the electrical engineer of that company.

The magnitude of the order will be appreciated from the fact that the station will have a larger capacity than the Barton power station of Manchester Corporation, which at present contains three 25,000-kw. sets.

It will be, according to report, the largest private power station in Britain.

Obituary

George Urban, Jr., a pioneer in the electrical development of the Niagara Frontier, passed away at his home near Buffalo on Thursday evening, Feb. 23, after an illness of about three weeks duration. Mr. Urban was 77 years old, having been born in Buffalo in 1850. Mr. Urban was vice-president and director of Buffalo General Electric Company, president and director of Niagara Electric Service Corporation and director of Buffalo, Niagara & Eastern Power Corporation.

Personal Mention

A. V. Farr, mechanical engineer, has been appointed sales promotion manager of the Johns Manville Corporation, 292 Madison Ave., New York City.

G. H. Van Hengel, member of the A.S.M.E., is now connected with the engineering department of the American Steam Pump Company, Battle Creek, Mich.

Theodore M. Knoop, mechanical engineer with the Worthington Pump & Machinery Corporation, who has been located at New York City, is now at Harrison, N. J.

Porter Hurd recently resigned from the Surface Combustion Company, Boston, to serve as industial engineer for the Philadelphia Gas Works Company, 1402 Arch St., Philadelphia.

General William H. Bixby was the representative of the American Society of Mechanical Engineers at the meeting of the Joseph A. Holmes Safety Association held March 5 at Washington, D. C.

J. R. LeVally, mechanical engineer, has been appointed special engineer connected with the district sales office of the Erie City Iron Works, which has been established at 122 South Michigan Avenue, Chicago.

Einar Ryden, member of the A.S.M.E., who has been connected with the Northwest Engineering Company, Green Bay, Wis., is now with the Link Belt Company, 310 West Pershing Road, Chicago, as design engineer.

Andrew A. Bato, A.S.M.E. member, lately resigned his position with the Public Service Production Company of New Jersey, and is now practicing as consulting engineer on problems of power, combustion, steam and heat efficiency and economy, and heating and ventilating. Mr. Bato is head of the engineering department of the New Jersey Laundry Owners Association.

E. E. Arnold has again become associated with the Westinghouse Electric & Manufacturing Company, in the capacity of mechanical engineer for special assignment, after an absence of 20 years from the company.

Lewis Buckley Stillwell, of New York, has been re-elected chairman of the Engineering Foundation, the research organization of the national engineering societies. Mr. Stillwell, who enters upon his fourth term, is past-

president of the American Institute of Electrical Engineers and the American Institute of Consulting Engineers.

H. H. JUDSON, formerly testing engineer with the Brooklyn Edison Company, has been promoted to the position of safety engineer of the personnel and statistics department.

Society Affairs

AMERICAN WATER WORKS ASSOCIATION, Florida Section, will hold its second annual meeting at the San Juan Hotel, Orlando, April 3-4; E. L. Filby, secretary, P. O. Box 135, Jacksonville, Fla.

AMERICAN WATER WORKS ASSOCIATION, Illinois Section, will hold its 20th annual meeting March 29-30, at the University of Illinois, Urbana. M. L. Enger, professor of mechanics and hydraulics, University of Illinois, is secretary.

A.S.M.E.—Engineers' Club of San Francisco, March 29, 7 p.m. Subject: "The Design of Steam Electric Generating Stations," by R. C. Powell, assistant chief of division of electric distribution and steam, Pacific Gas & Electric Company, of San Francisco.

A.S.M.E.—Philadelphia — Engineers' Club of Philadelphia, 1317 Spruce St., Philadelphia, March 27; dinner at 6 p.m. Meeting at 8 p.m. Subjects: "Progress in the Burning of Coal," by Prof. A. G. Christie, professor of mechanical engineering, Johns Hopkins University, Baltimore, Md. "Special and Anti-Knock Fuels," by Dr. Graham Edgar, director of research, Ethyl Gasoline Corporation, New York; "Recent Developments in Low Temperature Carbonization," by Col. H. D. Savage, president of the Dry Quenching Equipment Corporation, New York.

LEWIS INSTITUTE BRANCHES OF THE A.I.E.E. AND WESTERN SOCIETY OF ENGINEERS, 1951 West Madison St., Chicago, have announced their second annual engineering exposition, to be held May 16-18.

A.S.M.E., CLEVELAND SECTION, Cleveland Engineering Society Rooms, 7:30 p.m., April 2, symposium on the "Progress and Status of Engineering Standardization in Cleveland." George T. Trundle, consulting engineer, will be the principal speaker. Col. E. C. Peck will be chairman of this meeting.

PROVIDENCE ENGINEERING SOCIETY—At 8 o'clock, April 3, the power section, A. E. Cameron, chairman, will be addressed by Melvin D. Engle, assistant to superintendent, station engineering department, construction bureau of the Edison Electric Illuminating Company of Boston, speaking on "The First Commercial 1,200-Lb. Steam Plant in the World."

Coming Conventions

American Association of Engineers, annual convention, El Paso, Texas, June 4-6; M. E. McIver, secretary, 63 Adams St., Chicago.

American Institute of Electrical Engineers, Baltimore Regional Meeting, District No. 2. April 17-19; New Haven Regional Meeting, Northeastern District, No. 1, in May; Summer Convention, in Denver, June 25-29.

American Institute of Refrigeration, Washington, D. C., May 10-11.

American Refractories Institute, annual meeting at White Sulphur Springs, W. Va., May 8-9; Dorothy A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh.

American Society of Refrigerating Engineers, meeting at Detroit, June 4-7; W. H. Ross, secretary, 37 West 39th St., New York City.

American Society of Heating and Ventilating Engineers, Summer meeting at West Baden Springs Hotel, West Baden, Ind., June 26-29; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers, spring meeting in Pittsburgh, May 14-17; Calvin Rice, secretary, 29 West 39th St., New York City; Twin-City regional meeting at St. Paul, Aug. 27-30; Boston regional meeting, Oct. 1-3.

American Society for Testing Materials, Atlantic City, June 25-29.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

Association of Iron and Steel Electrical Engineers, annual convention and Iron and Steel Exposition at Hotel Stevens, Chicago, June 25-29.

Indiana Fuel Conference at Purdue University, Lafayette, Ind., April 5-6.

National Association of Power Engineers, annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago.

National Board of Boiler and Pressure Vessel Inspectors, meeting at Erie, Pa., June 18-20.

National Electric Light Association, Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

National District Heating Association, annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Universal Craftsmen Council of Engineers, Newark, N. J., Aug. 7-10.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

Business Notes

THE CASEY-HEDGES COMPANY, INC., Chattanooga, Tenn., has engaged the services of William Wallace, Jr., as representative in the sale of boilers in the Cleveland, Youngstown and Pittsburgh territory, with offices at 1111 Union Mortgage Bldg., Cleveland. Mr. Wallace formerly represented the Erie City Iron Works.

STONE & WEBSTER, INC., has been authorized by I. E. Moultrop, chief engineer of the Edison Electric Illuminating Company of Boston, to design and construct extensions to the switchhouse and boiler house at the Charles Leavitt Edgar Station, at Weymouth, Mass.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.40@$2.65
Kanawha.....	Columbus.....	125. @ 1.60
Smokeless.....	Cincinnati.....	2.25
Smokeless.....	Chicago.....	1.75@ 2.25
S. E. Kentucky...	Chicago.....	1.35@ 1.75
Steam.....	Pittsburgh.....	1.60
Gas Slack.....	Pittsburgh.....	1.05
Big Seam.....	Birmingham....	1.50@ 2.00
Anthracite (Gross Tons)		
Buckwheat.....	New York.....	$2.75@$3.25
Birdseye.....	New York.....	1.60

FUEL OIL

New York—Mar. 22, industrial use, tank-car lots, 28@34 deg., Baumé, 4½@5c. per gal.; 36@40 deg., 5½@6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Mar. 6, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.65 per bbl.; 28@30 deg., $1.70 per bbl.; 30@32 deg., $1.75 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 5.15c. per gal.

Pittsburgh—Mar. 13, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5¼c. per gal.

Philadelphia—Mar. 14, 26@30 deg., $2.00@$2.06 per bbl.; 13@19 deg., $1.26 @$1.32 per bbl.; 22 plus, $1.58@$1.64 per bbl.; 27@30 deg., $2.10@$2.16 per bbl.

Cincinnati—Mar. 13, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5¼c. per gal.

Chicago—Mar. 17, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., 90@95c. per bbl.; 30@32 deg., $1.10 per bbl.

Boston—Mar. 19, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.35c. per gal.; 28@32 deg., 5.8c. per gal.

Dallas—Mar. 9, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

THE SPRAY ENGINEERING COMPANY, INC., announces the opening of a new branch office at 15 Park Place, New York City.

BENTLEY & HOLMGREN, Room 406, Court Exchange Bldg., Bridgeport, Conn., have just been appointed to represent Foote Bros. Gear & Machine Co. in Connecticut and western Massachusetts.

THE AMERICAN PULVERIZER COMPANY, manufacturer of the American Rolling Ring Crushers, has moved from Eighteenth and Austin Sts., St. Louis, Mo., to a new, modern plant located at 1249-53 Macklind Avenue.

L. S. SHAW & COMPANY, Cleveland, have reorganized under the name of L. S. Shaw & Son, C. D. Shaw having entered the firm under date of Feb. 15. The organization is now composed of three generations, E. D. Shaw, L. S. Shaw and C. D. Shaw, in the boiler equipment business.

THE BLUE RIDGE POWER COMPANY, Manassas, Va., has just been chartered, to develop and operate steam and hydro-electric plants and other works for the generation of electric light and power. The incorporators are: Charles W. Alpaugh, president; Walter A. Alpaugh, secretary, both of Manassas; Morris H. Leaver and Willis W. Vail, both of Quakertown, N. J., and Luther A. Alpaugh, of Manassas.

THE CANADIAN POWER SPECIALTY COMPANY, St. Catherines, Ontario, has just made final shipment of materials on its contract with the Spruce Falls Power & Paper Company, for the new mill at Kapuskasing, Ontario. The equipment supplies consisted of water-cooled furnaces, economizers, superheaters and four Aero side "J" coal pulverizers. The equipment is for four boiler units of 1,034 hp. each.

MURRAY IRON WORKS, Burlington, Iowa, announces the recent appointment of the following district sales managers and agencies: Atlanta, Ga., McBurney Stoker & Equipment Company, 619 Trust Co. of Ga. Bldg.; Boston, Mass., Starkweather & Broadhurst, Inc., 79 Milk St.; Cleveland, Ohio, Stephan Company, 7016 Euclid Ave.; Los Angeles, Cal., Chase Terry, 2084 W. 29th St.; Montreal, Can., Bishop Sales Corporation, Keefer Bldg., 698 St. Catherine St., West; New Orleans, La., Buckmaster - Luck - Malochee, 617 Common St.; New York City, Honolulu Iron Works Company, 165 Broadway; Philadelphia, Pa., H. R. Hanson, 2200 Packard Bldg.; Portland, Ore., Power Equipment Company, 816 Lewis Bldg.; Pittsburgh, Pa., James T. Castle, 1601 Arrott Bldg.; San Francisco, Calif., Halloran & Paradee, Sharon Bldg.; St. Paul, Minn., A. R. Robertson Company, 1603 University Ave.; Seattle, Wash., Thomas S. Wood, 505 Polson Bldg., and Vancouver, B. C., Frank Sawforth, 609 Credit Foncier Bldg.

Trade Catalogs

ELECTRIC HOISTS — Silent Hoist Winch & Crane Company, manufacturing worm-drive hoisting machinery, 762-772 Henry St., Brooklyn, N. Y., has issued a new bulletin, No. 27, featuring different types of Silent hoist vertical and horizontal capstan winches, and single- and double-drum winches, self-contained units complete with electric motor and gasoline drive. Suitable for either portable or stationary use, these winches are adapted for general pulling and hoisting in and about power plants.

NEW PLANT CONSTRUCTION

Ark., Camden—Camden Ice & Coal Co., R. S. Martin, Pres., awarded contract for a 30 ton ice plant to T. Wilmoth. Estimated cost $50,000.

Ark., Little Rock—Arkansas Cold Storage Co., C. E. Rose, Mgr., Ft. Rock St., is having preliminary plans prepared for the construction of a cold storage warehouse. Estimated cost $100,000.

Calif., Berkeley—University of California, had plans prepared for a 5 story life science building on University campus. Estimated cost $2,500,000. G. W. Kelham, 315 Montgomery St., San Francisco, is architect.

Calif., Coronado—Island City Hotel Co., c/o R. M. Bates, Jr., 660 South Vermont Ave., Los Angeles, archt., is having plans prepared for an 8 story hotel here. Estimated cost $1,000,000.

Calif., Hynes—Clearwater Hynes County Water Dist., plans an election soon to vote $160,000 bonds for waterworks improvements including wells, pumping equipment, mains, etc. Burns-McDonnell-Smith Engineering Co., Western Pacific Bldg., Los Angeles, is engineer.

Calif., La Habra—City plans an election soon to vote $120,000 bonds for waterworks improvements including wells, pumps, etc.

Calif., Los Angeles—E. Small, et al, c/o Walker & Eisen, Western Pacific Bldg., Los Angeles, is having plans prepared for a 12 story apartment building on Rossmore Ave. Walker & Eisen, Western Pacific Bldg., are architects.

Calif., Sacramento — Financial Center Building Inc., c/o G. Sellon & Co., California State Life Bldg., Archts., awarded contract for a 10 story office building at 7th and J. Sts. to Campbell Construction Co., 800 R. St. Estimated cost $1,250,000.

Calif., San Bernardino—San Bernardino County Waterworks Dist. No. 4, plans an election soon to vote $40,000 bonds for the construction of a waterworks system including reservoir, pumps, etc.

Conn., Hartford—Central Co., E. Elsner, 75 Pearl St., awarded contract for a 6 story office and stores building at Main and Asylum Sts. to M. A. Connor Co., 561 Main St. Estimated cost $750,000.

Conn., Hartford — Russ Street Corp., 1026 Main St., will build an apartment building including electric refrigeration system, etc. on South Marshall St. Estimated cost $600,000. Private plans.

Idaho, Boise — W. E. Pierce, Promoter, Pacific National Bank Bldg., had preliminary plans prepared for the construction of an 11 story hotel at 8th and Bannock Sts. Estimated cost $700,000. Turtellotte & Hummell, Portland, Ore. and Boise, Idaho, are architects.

Ill., Chicago—Commonwealth Edison Co., 72 West Adams St., awarded contract for masonry, etc. for a sub-station at 262 Harding Ave. N and 6136 Crawford Ave. Estimated cost $80,000.

Ill., Chicago—Foreman National Bank, 30 North La Salle St., is having plans prepared for a 40 story bank and office building at Washington and La Salle Sts. Graham, Anderson, Probst & White, 80 East Jackson Blvd., are architects.

Ill., Evanston—H. S. Jones, 1428 Noyes St., will soon receive bids for the construction of a 7 story co-operative building including electric refrigeration system, etc. at Hinman Ave. and Grove St. Estimated cost $850,000. Hall, Lawrence, Rippel & Ratcliffe, 123 West Madison St., Chicago, are architects.

Ind., Fort Wayne—American Gas & Electric Co. is having plans prepared for the construction of a new switch house. Estimated cost $145,000. Private plans.

Ind., Muncie—George Challis, is having plans prepared for a 5 story hotel and theatre building including steam heating system, elevators, etc. Estimated cost $500,000. A. M. Strauss, 415 Cal-Wayne Bldg., is architect.

La., New Orleans—Commercial Hotel Co., Maison Blanche Bldg., will soon award contract for an 18 story hotel including steam heating system, elevators, etc. on Common St. Estimated cost $1,000,000 Jones, Roessle & Olschner, Maison Blanche Bldg., are architects.

Mass., Boston—Dept. of Public Buildings, will receive bids until Apr. 4, for the construction of a boiler plant for Suffolk County jail, Charles St.

Mass., Cambridge (Boston P. O.)—Boston Ice Co., 110 State St., Boston, will soon award contract for the construction of an ice plant at Second and Charles Sts. here.

Mass., Fall River — City, B. H. Fuller, Supt., Municipal Bldg., is having sketches made for the construction of a hospital. Estimated cost $600,000. J. I. Higgins, Academy Bldg., is architect.

Mass., Lowell—Lowell Hotel Co., J. A. Simpson, Agt., is having plans prepared for a 6 story hotel on Kearney Sq. Estimated cost $500,000. Thomas, Martin & Kirkpatrick, 200 South 16th St., Philadelphia, Pa., are architects.

Mass., Weymouth (Boston P. O.)—Edison Electric Illuminating Co., I. E. Moultrop, Ch. Engr., 39 Boylston St., Boston, awarded contract for the design and construction of switchhouse and boilerhouse extensions at Charles Leavitt Edgar station here to Stone & Webster, 147 Milk St., Boston.

Industrial Projects

Beginning with next week's issue (April 3) POWER will publish here a column of information on industrial projects containing business possibilities for POWER readers. Watch for this feature, follow it closely in each issue and profit by it.

Mich., Detroit—Book Estate, Book Bldg., awarded contract for a 12 story garage on Washington Blvd. to W. E. Wood Co., 1805 Ford Bldg. Steam heating system, boilers, etc. will be installed.

Mo., Kennett—City voted bonds Mar. 14, for the construction of an electric light and power plant.

Mo., Marshall—City voted $80,000 bonds for extensions and improvements to electric light plant. Henrici-Lowry Engineering Co., 402 Security Bldg., Kansas City, is engineer.

Mo., St. Louis—Dollar Investment Co., J. Feldman, 4409 West Pine St., awarded contract for a 15 story hotel at Eighth and Pine Sts. to J. W. Kopman Construction Co., 594 Arcade Bldg. Estimated cost $1,200,000. Steam heating system, etc. will be installed.

Mo., St. Louis—The Heiss Hotel Co., c/o C. Heiss, Hotel Mayfair, will build a 23 story hotel including steam heating system, etc. at Washington Ave. and Ninth St. Estimated cost $1,500,000. Work will be done by separate contracts under the supervision of Preston J. Bradshaw, International Life Bldg., Archt.

Mo., St. Louis—Sears, Roebuck & Co., Arthington and Homan Sts., Chicago, Ill., will soon receive bids for the construction of a department store at Kingshighway and Easton St., here. Estimated cost $750,000. G. Nimmons & Co., 122 South Michigan Ave., Chicago, Ill., are architects.

Mo., Webster Groves (St. Louis P. O.)—Laymer Realty Co., c/o A. J. Widmer, Pres. Widmer Engineering Co., Laclede Gas Light Bldg., St. Louis, engr., plans the construction of an apartment building including steam heating system, etc. at Lockwood and Maple Aves. Estimated cost $900,000.

N. J., Bloomfield—Bd. of Council, Essex Bldg., will soon receive bids for the construction of a boiler house on Franklin St. Estimated cost $40,000.

N. J., Jersey City — Loews Theatrical Enterprises, 1540 Broadway, New York, N. Y., will soon award contract for the construction of a theatre including steam heating and ventilation systems, boilers, etc. at 54-58 Journal Sq., here. Estimated cost $1,500,000. C. W. and G. L. Rapp, Paramount Bldg., New York, N. Y., are architects.

N. J., Jersey City — N. Matler, 1902 Boulevard, is having plans prepared for a 5 story apartment building including steam heating and refrigeration systems, boilers, elevators, etc. at Academy St. and Van Reypen St. Estimated cost $500,000. N. Welitoff, 3010 Boulevard, is architect.

N. J., Paterson—Pure Ice Co., 17 North First St., awarded contract for the construction of an ice plant at 21-23 North First St. to Truscon Steel Co., 1060 Broad St., Newark. Estimated cost $40,000.

N. Y., Brooklyn — Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Mar. 28, for the construction of a refrigeration plant, here.

N. Y., Brooklyn — M. McCormack, 376 Woodward Ave., is having plans prepared for the construction of an apartment building. Estimated cost $750,000. B. Dreisler Jr., 153 Remsen St., Archt. Work will be done under the supervision of Realty Associates, 162 Remsen St.

N. Y., Brooklyn—E. H. Patrick, 183rd St. and Pinehurst Ave., Hudson View Gardens, New York, had plans prepared for a 15 story apartment building at Prospect Park W. and President St., here. Estimated cost $600,000. Sugarman & Berger, 345 Madison Ave., New York, are architects.

N. Y., New York—Fifth Ave. and Twenty Ninth St. Corp., L. W. Flauniacher, Pres., 330 5th Ave., had plans prepared for a 26 story stores building at 259 5th Ave. Estimated cost $3,500,000. Buchman & Kahn, 2 Park Ave., are architects.

N. Y., New York—Goldbelt Realty Corp., M. B. Steven, Pres., 408 Lexington Ave., had plans prepared for the construction of a hotel at 585 Lexington Ave. Estimated cost $960,000. W. VanAlen, 331 Madison Ave., is architect.

N. Y., New York—Manhattan Congregational Church, awarded general contract for a 23 story church and hotel at Broadway and 76th St. to White-Stark Co., 420 Lexington Ave. Estimated cost $2,000,000.

N. Y., New York—State of New York, awarded contract for the construction of an office building to Cauldwell-Wingate, 101 Park Ave. Estimated cost $2,774,000.

N. Y., St. George (Staten Island P. O.)—Dept. of Public Welfare, B. S. Coler, comr., 10th floor, Municipal Bldg., New York, will receive bids until Mar. 29 for the installation of a refrigeration plant in Sea View Hospital, Borough of Richmond.

O., Cincinnati — Century Athletic Club, 830 Provident Bank Bldg., plans a 15 story club building at 5th and Sycamore Sts. Estimated cost $2,500,000. Rendigs, Panzer & Martin, 609 Southern Ohio Bank Bldg., are architects.

Okla., Mangum — L. E. Teter, is having plans prepared for the construction of a cold storage plant. Estimated cost $50,000. Private plans.

Pa., Pittsburgh—The Koppers Co., Union Trust Bldg., awarded contract for a 32 story office building at Grant St. and 7th Ave. to The Mellon Stuart Co., Oliver Bldg. Estimated cost $5,000,000.

Pa., Pittsburgh — The Stanley Theatre Corp., 1916 Race St., Philadelphia, will build a theatre at Penn. and Euclid Aves., here. Estimated cost $2,000,000. Work will be done by separate contracts under the supervision of Hoffman & Henon Co., Finance Bldg., Philadelphia, Archts.

Pa., Pittsburgh — U. S. Engineer Office, will receive bids until Apr. 5, for the construction of a power house for Lock 6, Allegheny River.

R. I., Providence—Providence Wholesale Food Terminal, c/o Jenks & Ballou, 1035 Grosvenor Bldg., Archts., is having plans prepared for the construction of a produce terminal including central power plant, refrigeration and cold storage plants, etc. Estimated cost $3,000,000.

Tenn., Union City—City plans an election May 10 to vote $200,000 bonds for extensions and improvements to water and light plant, etc.

Tex., Fort Worth—C. A. O'Keefe, 520 South Summitt St., will soon receive bids for a 15 or 16 story hotel at 5th and Main Sts. Estimated cost $750,000. Architect not announced.

Tex., Houston — St. Pauls Methodist Church, J. N. R. Score, 3402 Cranstark St., is having plans prepared for the construction of a church and educational building including boiler room, etc. at Main Blvd. between Binz and Calumet Sts. Estimated cost $500,000. A. C. Finn, 505 Bankers Mortgage Bldg., is architect.

Tex., Jacksonville—Southern Pacific Co., 65 Market St., plans shop and yard improvements including reconstructing and relocating power plant, engine house, etc. here. Total estimated cost $160,000. G. W. Boschke, is chief engineer.

Va., Richmond — Virginia Electric & Power Co., W. E. Wood, Pres., Electric Bldg., plans to expend $4,000,000 for extensions and improvements to their system at Tidewater, Va., North Carolina and Norfolk. Rebuilding of tracks, purchases of motor buses and improvements to street cars, etc. will cost approximately $1,000,000.

Vt., Springfield—City is having sketches made for a power development. C. T. Main Inc., 201 Devonshire St., Boston, is engineer.

Wash., Oak Harbor—City will soon award contract for the construction of a waterworks system including deep well turbine pump, etc. W. T. Batcheller, Inc., Dexter Horton Bldg., Seattle, is engineer.

Wash., Seattle—F. McDermott, Second and Union Sts., Bon Marche Department Store, awarded contract for the construction of a department store to Teufel & Carlson, Skinner Bldg. Estimated cost $3,000,000.

Wash., Seattle—Northern Life Insurance Co., 1118 4th St., awarded contract for the construction of a 27 story building to Sound Construction & Engineering Co., Lowman Bldg. Estimated cost $1,500,000.

Wash., Seattle—R. C. Reamer, Skinner Bldg., Archt., will receive bids until Apr. 11 for a 15 story office building at Third and Union Sts. for C. D. Stimson & Associates, Skinner Bldg. Estimated cost $1,000,000.

B. C., Nelson—City plans an election Apr. 14, to vote $240,000 bonds for the installation of an additional unit to municipal power plant at Bonnington. L. A. Campbell, Rossland, is engineer.

B. C., Vancouver—Bd. of School Trustees, 590 Hamilton St., will soon award contract for the construction of a technical school including boiler room, etc. at Broadway E. and Clinton St. Estimated cost $500,000. W. H. Postle, 590 Hamilton St., is architect. P. P. Brown, 407 London Bldg., is engineer.

Ont., Fort Erie—Fort Erie Artificial Ice Co., E. W. Johnston, Pres., Box S., awarded contract for the construction of an ice arena on Front St. to Taber Ford Construction Co., 553 St. Clair Ave., Toronto. Estimated cost $200,000.

Ont., Toronto—Bennett Investment, Ltd., Temple Bldg., is having plans prepared for a 15 story office building including steam heating system, elevators, etc. at Piper and York Sts. Estimated cost $1,000,000. H. G. Buerr, Lumsden Bldg. and E. L. Sheppard, 57 Queen St. W., are architects.

Ont., Hamilton—Pigott-Healey Construction Co., 36 James St. S., will build a 14 story office building including steam heating system, elevators, etc. Estimated cost $1,000,000. B. H. Prack, 42 James St. N. is architect. Work will be done by separate contracts.

Ont., Stoney Creek — City Council plans an election to vote on bylaw for waterworks improvements including pumping station, etc. Estimated cost $90,000. Wynne-Roberts Son-McLean, Metropolitan Bldg., Engr.

Ont., Toronto—Canadian National Exhibition, Lumsden Bldg., will soon award contract for the construction of an engineering and electrical building in Exhibition Park. Estimated cost $750,000. Chapman & Oxley, Northern Ontario Bldg., are architects.

Ont., Toronto — H. Falk, 23 Woodside Ave., awarded contract for a 16 story office building at Adelaide and Sheppard Sts. to John V. Gray Construction Co., Northern Ontario Bldg. Estimated cost $650,000. Steam heating system, electric elevators, etc. will be installed.

Equipment Wanted

Artificial Ice Plant—Fort Erie Artificial Ice Co., Box S, Fort Erie, Ont., prices on artificial ice plant for proposed new arena.

Boiler and Condenser—City of Marshall, Mo., will receive bids until Mar. 30, for a 500 hp. boiler and 1,500 kw. condenser.

Boiler and Engine—Cleophas Beaudoin, 7003 De St. Valier St., Montreal, Que., plans to purchase one 50 hp. steam boiler and one 10 hp. steam engine.

Boilers—Treasury Dept., Office of Supervising Architect, Washington, D. C., will receive bids until Apr. 9, for the installation of three new boilers in U. S. Post Office and Court House at Pittsburgh, Pa.

Boilers, Engines, Etc.—Engineer Office, War Dept., Washington, D. C., is receiving bids for boilers, two derrick engines, etc. at New Orleans, La.

Boilers, Pumps, Water Heater, Compressor, Etc. — Quartermaster Supply Office, Brooklyn, N. Y., will receive bids until Apr. 2, for two 35 hp. steam boilers, two boiler feed pumps, one feed water heater and one ammonia compressor.

Generators, Pumps, Switchboard, Etc.—Bd. of Trustees of Westchester Joint Waterworks No. 1, Mamaroneck, N. Y., will receive bids until Apr. 6, for furnishing and installing two Diesel engine generators, two 3 m.g.p.d. high lift motor driven centrifugal pumps and two 3 m.g.p.d. low lift motor driven centrifugal pumps, switchboard, etc. for proposed filtration plant and remodeling of pumping station.

Metallic Packing—G. T. Conkling, Ch. Engr., New Jersey State Sanitarium, Glen Gardner, N. J., is in the market for metallic packing for steam hp. on rods, valve stems, etc.

Pump—City of Roxanna, Okla., plans to purchase a deep well pump and motor for proposed waterworks improvements. Estimated cost $30,000.

Pump, Engine, Etc. — Bd. of Water Comrs., Marshfield, Mass., will receive bids until Apr. 7, for furnishing and installing two duplicate pumping units each consisting of a 10 x 12 in. vertical triplex deep well pump and 50 hp. Diesel engine for proposed pumping station.

Pumps, Blowers, Etc. — J. M. Stewart, Dir. of Public Service, Kenmore, O., will receive bids until Apr. 2, for pumps, blowers, etc. for proposed sewage treatment plant.

Pumps, Etc.—City of Livingston, Calif., will receive bids until Apr. 16 for pumps, etc. for proposed waterworks improvements. Estimated cost $40,000.

Transformers—City of Cleveland, O., will receive bids until Mar. 30, for power transformers, distribution tansformers, etc.

Turbine and Generator — Galetta Power Co., Arnprior, Ont., plans the installation of a 400 kva. turbine and generator with governor, switching equipment, etc. in plant at Galetta, Ont. Estimated cost $20,000.